PROLIFIC BREEDERS, ADAPTABLE FEEDERS

A tough and most adaptable animal, the domestic pig is able to live in a wide range of conditions, and will forage for fruit and nuts (see below), dig for roots and grubs, as well as eat the occasional small dead or living animal.

Most of our present day domestic pig breeds have been moulded into their present forms within the last 90 to 100 years. The ancestors of all our domesticated swine are thought to be the European wild boar and the wild pig of south-east Asia.

The domestic pig still retains many of its wild relative's characteristics. Its bristly hide is nearly as tough as armour-plating at the shoulders, and a fearsome full set of teeth, including the adult boar's incisor tusks, equips the pig to defend itself with ease.

A pig has cloven feet like cattle and sheep, and though its legs are short it can run fast over short distances. Its hearing is acute, its eyesight adequate and its snout, excellent

Above: Beauty treatment. When a pig becomes too hot, sunburnt or finds its skin cracking, it is liable to wallow in mud—if any is available—to relieve the suffering.

at smelling, is also an ideal implement for digging and levering. In some places in Europe pigs are trained to sniff out the potato-shaped fungi called truffles, which the owner then digs up for food. Colour varies between the different breeds but in the British Isles it is predominantly white. Coloured pig breeds can tolerate hot sunshine but the white breeds suffer from acute sunburn if no shelter is available.

Clean or dirty. Many people label pigs unfairly as dirty animals. If pigs, which in the wild live in stable family groups, are allowed to choose their preferred living conditions in mixed woodland country, they make a clean semi-covered nest of grass, leaves and branches. The nest is rarely soiled and dung and urine are deposited well away from the nesting site. It is only when pigs are kept in intensive, crowded conditions that they foul their living and sleeping areas.

Greedy as a pig Pigs have hearty appetites and a remarkably fast growth rate. Their ability to thrive on a wide range of foodstuffs is one reason why man finds it economical to keep them.

A pig has a simple single-stomach digestive system. Unlike the cow and the sheep it does not have a rumen and normally does not eat grass. Pigs root for grubs and worms, but eat many other foods as well including all sorts of vegetables, acorns and nuts, the leaves of bushes and trees, and small animals, either living or as carrion. They also devour any scraps and left-overs from the kitchen.

The modern pig is an omnivore, but the majority of breeds are reared in special pig houses and given 'balanced' diets based on ground cereals such as barley and wheat for energy, with added protein ingredients such as fishmeal and imported soya bean meal, minerals and vitamins.

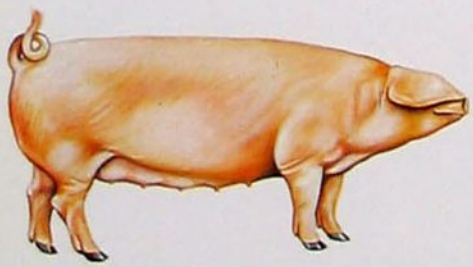
Prolific breeding A well-nourished sow is ready to breed by the time she is six to seven months old, and produces litters of piglets regularly for four to five years. The pregnancy period varies from 112 to 120 days, depending on the breed or cross, and a sow in good condition can produce two litters of young each year. Litter numbers vary, although 10 is usual and up to 15 not uncommon. Most farmers allow their domesticated sows to suckle their young for a period varying from one to eight weeks.

Pork or bacon? Pigs are reared for the production of pork meat, bacon and the manufacture of sausages, ham, pies and packed and tinned foods. Each breed of pigs is to some extent a pork, a bacon, or a dual purpose type. The Large White, the Landrace and the Welsh are the major bacon breeds. The Berkshire and Middle White, being shorter, wider and smaller in size, give good pork and useful small bacon cuts. Other breeds can be reared for either purpose, depending on the farmer's management and selection. Crossbreds are reared on many farms.

Indoor or outdoor housing The types of housing used for pigs have developed rapidly over the last 20 years. Although Saddleback, Large Black, Tamworth and Gloucestershire Old Spot pigs—and their crosses—thrive on free range farms with simple huts for shelter, most of the British pig breeds are housed all the year round. The simple draughty sty with a restricted and often dirty outside run, is now replaced by larger, well-insulated buildings, or open fronted houses with a complete roof. So-called intensive methods have to be well run by a good stockman, and if suitable warmth, food & clean housing are provided, pigs thrive just as well under

Middle White Breed evolved by crossing Large White and Small White (extinct) pigs. Early maturing pork breed.

Gloucestershire Old Spot Dual purpose kept mainly for general farming and crossing purposes.



Welsh The natural docility, hardiness and damming ability (nine pigs average per litter) has resulted in a growing demand for Welsh pigs.

Hampshire Introduced from America and used primarily for crossing, or in hybrid production. A robust breed and adaptable to various kinds of climate.

Large White On many occasions called the 'universal breed' as it provides top grade meat for the pork, bacon and packaging markets.

cover as in more natural conditions.

However, modern pig buildings are extremely expensive, and some farmers have reverted to cheaper outside methods in parts of the country where the soil and climate suit the system. Free-range sows are now a common sight on free-draining land in the Thames Valley, Dorset, Devon and Cornwall. The free-draining sandy land in East Anglia and Norfolk in particular are ideally suited for running breeding sows and piglets outside. Pigs live happily outside in warm weather but a variety of simple huts are usually provided to give protection against wind, rain and snow.

Berkshire An early maturing breed, this pig is reared for pork. It was the first modern breed to be developed, although today it is used mainly to produce crossbreeds, as the progeny are good bacon pigs.

Middle White A breed that is a smaller, neater version of the Large White, although the face is more heavily dished. It is used for producing pork, either directly or by crossing it with other breeds such as the Berkshire.

Gloucestershire Old Spot pigs survive mainly in their native county where they can live on windfalls in the orchards that are found in the Severn Valley, hence their other name 'Orchard Pig'.

Large Black This breed owes its name to the colour of its hair, not to its skin which is not heavily pigmented. This very docile pig is a dual-purpose breed.

Tamworth A breed that more closely resembles the wild pig than any other breed of British pig. Although slow-maturing, its long, smooth side, neat shoulder and firm flesh make it very suitable for bacon.

Large White A most popular dual-purpose pig, the most numerous breed in Britain. It is a hardy breed and usually trouble-free in rearing, growing and converting food efficiently. It is suitable for outdoor breeding as well as for indoor management.

British Landrace This breed is developed largely from Landrace pigs imported from Sweden in 1949 and 1953. Although its long, lean build gives excellent bacon, the breed is today reared for pork as well.

Welsh A hardy, dual-purpose breed, able to thrive and give good results under a wide range of conditions. There is a growing demand for Welsh pigs, due to consistently good performances in breeding, rearing and quality of meat.

British Saddleback A breed noted for its hardiness, several herds being run in completely open-air conditions. The breed seen today is a result of the merger between the similar Essex and Wessex Saddleback breeds.

Hampshire pigs are now firmly established as a British breed. Introduced from America, where they have a long record for high quality lean meat, they are suitable for all types of pig farming.

Above: The good life? Newborn piglets are completely dependent on their mother's milk supply for the first two or three weeks, but they are inquisitive and soon sample water and adult food. Many farmers wean piglets on to solid food around three weeks of age.

Berkshire An early maturing pork breed. Originated in the Thames valley in late 18th and 19th centuries.

British Saddleback Formed in 1967 from the amalgamation of the Essex and Wessex breeds.

Large Black Ideal breed for crossbred pig production, make outstanding mothers. Hardiness allows them to be kept out of doors.

Tamworth An ancient breed with a distinctive red-gold coat. An open-air pig, the sow has a docile temperament, being a good mother and not clumsy with her litter.

British Landrace The sow is a good breeder and a docile animal. A popular choice for a hybrid parent. Originally a bacon breed but now often dual purpose.

CREEPING FRESHWATER MUSSELS

From tiny pea mussels to pearl producers, there are 28 species of freshwater mussel to be found in canals, rivers, lakes, and even ditches and drains all over the British Isles.

Freshwater mussels are molluscs, with many features in common with their close relatives, the marine oysters and mussels. They are all bivalves–their bodies being enclosed in two flap-like shells known as valves. These valves are formed from secretions of the mussel's outer skin (the mantle), and extend as two sheets on either side of the body.

Slow-motion swan mussels The five larger species of freshwater mussel are the most frequently found. Of these, the swan mussel is the largest–growing up to 22cm (8¾in)–and most common, occurring in canals, lakes, ponds and reservoirs all over the British Isles, apart from the extreme south-west of England, and the north of Scotland. Like all mussels, it obtains food and oxygen from the water which enters the mantle cavity through a special aperture, the inhalant siphon, while the valves are partly open. The clean oxygen-bearing water flows through the two lattice-like large gills on either side of the body. The surfaces of the gills are covered with thousands of microscopic beating threads called cilia, that cause the water to flow in through the siphon and over the gills, bringing in oxygen and taking away carbon dioxide. The gills are ideally placed to sift small particles of food, such as microscopic plants and animals, out of the water. These are trapped in slime on the gills and swept towards the mouth by special ciliated pathways. The swan mussel therefore does not need to move to catch its food. All the sustenance it needs is pumped in with the respiratory water.

Movement is possible in all the mussels by means of a blade-like foot which the mussel forces out through a gap in the open valves to lever itself slowly over the river bed. The mussel pushes forward the foot to make a furrow in the surface of the riverbed, and expands the tip to take a firm hold on the furrow wall, then shortens the foot hauling itself forward. This has to be repeated many times before the mussel moves any appreciable distance, and it has been calculated that it would take a freshwater mussel one year to move a mile. However, in times of

Above: The inhalant siphon, the frilled edge of which is visible here, is always exposed in the swan mussel *(Anodonta cygnea)*. A hinge at the top of the shell holds the two valves together, but it has to work against an elastic ligament which acts like a compression spring, forcing the valves apart. The mussel uses two sets of powerful adductor muscles–one at the front and one at the rear–to hold the valves closed. They work against the ligament, allowing the animal to protect itself by closing the valves completely. When the mussel wants to open the valves, it simply relaxes the adductor muscles.

drought, movement is necessary so that the swan mussel can leave the drying shallows to find a new location in deeper water.

Mussel reproduction In the breeding season (June to August) the male swan mussel releases sperm into the water near the female and some of this is drawn into her mantle cavity as she feeds, fertilising the eggs. The female stores the fertilised eggs in the outer folds of her gills, using them as brood pouches. Here the fertilised eggs develop into larvae, known as glochidia, which are miniature bivalves with a tooth on the edge of each valve. The larvae remain in the brood pouches for up to nine months, then they are expelled, clinging to weeds or in small clusters on the mud. When a fish swims by the larvae attach themselves to its fins or skin. They are carried around by the fish in this way, living parasitically until they are old enough to lead an independent life on the river bed.

The duck mussel is similar in so many respects to the swan mussel that its exact status as a separate species has been doubted. It is distinguished from the swan mussel by its slightly smaller size, and a shell which is more oval and swollen, particularly towards the front. The duck mussel is more widely distributed in Scotland than the swan mussel, and prefers moving water and sandy shallows, where it can burrow.

Artists' accessory Artists once used the shells of painter's mussels as containers for their paints–hence their name. They are longer and narrower than the swan and duck mussels, and they also differ in having teeth on the hinge of their shells. These are used to keep the two valves correctly aligned. The painter's mussel, which also reproduces by means of glochidia larvae, is found in slow-flowing rivers and canals over most of England and mid-Wales.

Pearl producer The pearl mussel sometimes produces valuable pearls inside its shell. Although in Roman times pearl fisheries were quite common, this mussel is now only locally fished commercially. It produces the pearl from nacre (mother of pearl) which lines the shell and is secreted to surround a foreign body, such as a sand grain, which has intruded into the shell. As it prefers fast-flowing soft water it is found mainly deep in the swift rivers of south-west and northern England, Wales and Scotland, where it burrows into the sand that accumulates in the lee of large boulders.

Marine relative The zebra mussel, its shell ornamented with a pattern of alternate, wavy, zig-zag bands of brown and yellow, is more closely related to the marine species of mussels. Found in slow-flowing rivers, canals, reservoirs and docks, it attaches itself to solid objects such as tree roots, pilings and the underside of barges, using sticky threads called byssus threads, that are a characteristic of marine mussels. These are secreted by a gland on the foot, and harden into strong, silken fibres.

Reproduction in the zebra mussel is similar to that of marine mussels. It produces a free-swimming larva which lives on tiny food particles until it matures and settles on a suitable object.

More mussels Other freshwater mussels include twenty species of pea mussel, a tiny but constant source of food for birds and fishes, and the horny orb mussel which is found among water plants in rivers and ditches. The larger freshwater mussels suffer very little from predators. The main threats to their well-being are drought, and the dredging of lakes and canals.

Above: **Zebra mussel** *(Dreissena polymorpha)*. 5cm (2in).

Below: **Pearl mussel** *(Margaritifera margaritifera)*. Up to 11·5cm (4½in).

Above: **Painter's mussel** *(Unio pictorum)*. Size up to 13cm (5in).

Below and right: **Duck mussel** *(Anodonta anatina)*.

Below: **Common orb mussel** *(Sphaerium corneum)*. 13mm (½in).

Right: **River pea mussel** *(Pisidium amnicum)*. Size 10mm (⅜in). Smaller varieties from 5mm (⅕in).

The valves of the shell of the painter's mussel (shown below) were not only used by early Dutch painters as containers for their colours, but were also considered to be an ideal size for the sale of the small quantities of gold and silver leaf used in illuminated manuscripts.

LOBED AND LEAFY LIVERWORTS

The flat green plants found on damp earth banks and pots of soil in the greenhouse are liverworts – close relatives of mosses, and once believed to cure liver diseases.

Above: *Lophocolea heterophylla* is a leafy liverwort, commonly found growing on decaying bark in damp woodland. It has branched, creeping stems which spread rapidly but reach only 1-2cm ($\frac{1}{2}$-$\frac{3}{4}$in) in length. In spring, it produces large numbers of black capsules on white stalks.

There are two types of liverwort – the lobed or thallose liverworts that are commonly found around greenhouses and on peatland, and leafy liverworts, which are found in damp places, among grass, beside streams and on rocks and tree trunks in wet northern and western woodlands. The name comes from the flat, lobed leaves of the thallose liverworts – whose shape vaguely resembles the human liver. Years ago it was believed that if a plant looked like a part of the body, it would be able to cure diseases of that particular part, hence the use of liverworts in treating liver disease. The plants themselves are small – one of the larger species, *Conocephalum conicum*, is only about 1·5cm ($\frac{1}{2}$in) broad – although they do spread, growing into fairly large carpets.

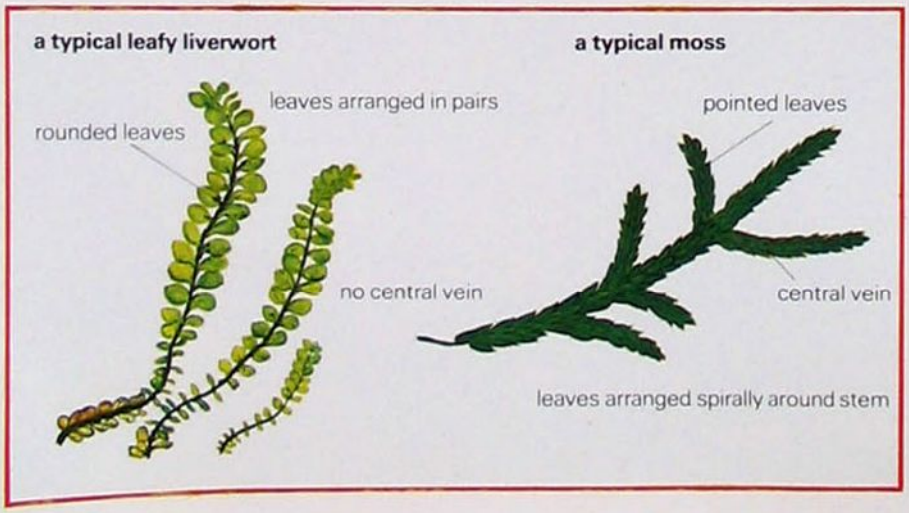
Lobed leaves The fleshy leaves of thallose liverworts appear in a wide variety of shapes, often lobed and divided. They do not have a midrib but are branched, creeping in carpets close to the ground. Some leaves have fine white hairs, known as rhizoids, on their undersides, both to hold them in place on the ground and to absorb nutrients. Thallose species such as *Marchantia polymorpha* and *Conocephalum conicum* have tiny hexagonal markings all over the leaves. These are the visible evidence of air chambers just below the surface. When observed closely with a lens, a tiny hole is apparent in the centre of each marking, allowing air to enter the chambers freely.

Rows of leaves Leafy liverworts differ from thallose liverworts in having two distinct rows of leaves, and a third set of less obvious underleaves. Although leafy liverworts are often confused with mosses, they differ in several respects. Moss leaves have a nerve or midrib which liverwort leaves lack and the moss leaves are arranged spirally around their stems. The spore capsules also differ – those of liverworts are short-lived and do not open with the violent miniature 'explosion' that is characteristic of moss spore capsules.

Reproduction Liverworts reproduce sexually or vegetatively; most species are capable of both. Sexual reproduction, as in mosses, takes place in alternate sexual and asexual (sporophytic) generations. The plant produces male and female organs, which appear in a wide variety of shapes depending on the species. The male parts can be umbrella or disc-shaped on stalks, or even develop on the leaves in small indentations or cushions. The female parts can be star or cone-shaped on stalks, or again develop on the leaves. After fertilisation has taken place, a spore-producing capsule develops on the end of a stalk, the sporophyte generation. When ripe, it splits open to reveal the spores. These are intermingled with pale greenish-brown threads, known as elaters, which twist and jerk, depending on the amount of moisture in the air, helping the spores disperse in the wind.

Vegetative reproduction takes place by means of tiny cups on the surface of the plants' leaves. These contain small disc-shaped pieces of specialised plant tissue called gemmae. When raindrops splash into the cups, the gemmae are displaced. Each one can then grow into a new plant.

Below: Diagram to show the most obvious differences between a moss and a leafy liverwort.



Spore development

Above: A patch of *Pellia epiphylla* showing black spore capsules, some of which have opened to reveal the spores.

Above: Close up of an open spore capsule of *Pellia epiphylla,* showing the spores and the elaters.

Left: *Marchantia polymorpha* showing the gemmae cups used in vegetative reproduction. When raindrops fall in the cups, the gemmae are splashed out and dispersed, growing into new plants.

Four thallose liverworts These liverworts vary widely in their reproductive structures. *Marchantia polymorpha*, commonly found around houses and gardens, particularly on damp brickwork, has umbrella-shaped male parts and star-shaped female parts, both carried on stalks. This species is one which can also reproduce vegetatively. *Lunularia cruciata* commonly found in or near greenhouses, generally reproduces vegetatively, the gemmae being partly surrounded by a crescent-shaped flap. *Pellia epiphylla*, another common liverwort, forms shiny green patches on wet banks. It reproduces sexually, the round black spore capsules appearing on delicate stalks up to 5cm (2in) long. *Riccia glauca* is a small thallose liverwort: the whole plant is usually less than 2·5cm (1in) in diameter, with short, branched lobes radiating to form a neat rosette which is a glistening pale green. It prefers moist soil, particularly in fields of stubble which have been left unploughed throughout the winter, a practice which is now rare and has thus adversely affected the distribution of this liverwort. The spores remain inside the fronds of the leaves and are not released until the plant dies and rots away.

A leafy liverwort trio One of our commonest leafy liverworts *Lophocolea bidentata* is found growing on damp banks and lawns, often with grass and mosses. Its shoots are very pale green and up to 5cm (2in) long, with two rows of leaves that are two-pronged at the tip. Another common leafy liverwort is *Plagiochila asplenioides* which grows in damp shady places, often on limestone soil. It is one of Britain's larger varieties; a well-grown plant can have shoots measuring 6-7mm (¼in) across and 10cm (4in) in length.

Most of the liverworts already described are to be found growing on the ground. By contrast, *Frullania tamarisci* is a species which is quite often found on the barks of trees. Each of the main leaves has a helmet-shaped lobe at its base, which traps water trickling down the tree trunk and may help the liverwort survive in a habitat where there is not always much water.

Below: *Conocephalum conicum* is a leafy liverwort which grows in lush carpets in damp places, such as rocks and walls in rivers and streams. When the plant is crushed it produces a scent, and this is one of the reasons why attempts are sometimes made to cultivate it. Unless kept in ideal conditions, it responds to cultivation by losing some of its colour and luxuriant growth, appearing pale and spindly.

WOODLAND DRUMMER-BIRDS

You can tell a spotted woodpecker by its frenzied activity even before you come close enough to recognise its brilliant colouring. Its persistent drumming against wood to attract a mate and proclaim territory is unique among British birds.

A male great spotted woodpecker removing wood excavated from its nest. In northern Britain nests are made in birch or pine, but in the south in hardwoods.

The great spotted woodpecker is both the most numerous and widespread of our woodpeckers, occurring in almost all areas where there are suitable trees. Strangely enough, the great spotted shares with its relatives a complete, unexpected, difficult-to-explain absence from the whole of Ireland, even though there is abundant suitable woodland. There have been occasional sitings in Ireland, but these seem to be of Continental migrants blown off-course in autumn, and none has stayed to breed. The lesser spotted woodpecker is much less common than the great. It does, however, share many characteristics of the great, and has all the same adaptations, though they are reduced in scale.

Woodland bird The great spotted woodpecker prefers stands of timber where at least some of the trees are mature, usually with a few dead or dying branches. It lives in both deciduous and coniferous woodlands, or a mixture of the two, but is scarcer in closely planted coniferous plantations without old or decaying trees. Where good hedgerows are still common, it penetrates deep into agricultural land, feeding and nesting in the tall trees of the hedge, or in spinneys and copses linked by the hedgerow network. It is unusual to find great spotted woodpeckers in

isolated clumps of trees.

The magnificent old trees of parkland offer an ideal habitat, and through parks the great spotted woodpecker sometimes penetrates into urban areas. It is a common species of large old gardens, with big trees, that meet the surrounding countryside.

Striking colouring With its pied plumage and scarlet patches, the great spotted woodpecker is a conspicuous bird. Its normal year-round call, a harsh and far-carrying 'tchack', or its staccato breeding-season drumming, quickly draw attention to its presence. Its deeply undulating method of flight, too, is conspicuous and characteristic, consisting of a few flaps of the rounded wings, followed by a deep swooping glide, before the next series of flaps helps it gain height again.

The wings are boldly barred black and white, with a striking white oval patch on each wing near the body–a feature lacking in the lesser spotted woodpecker. The back is plain black (again, different from the lesser spotted, where the white bars cross the back as well), and the underparts are white save for a bright scarlet patch beneath the tail of both sexes. In addition, the male has a small block of scarlet feathers on the nape of his otherwise black crown.

Woodpeckers perch, or rather cling, to the sides of tree trunks and branches in a characteristic head-up position developed in the course of evolution as the tail feathers have become specially strengthened and inflexible, serving as a third leg, or prop, to use in climbing in much the same way as we balance on a shooting-stick. This adaptation assists a particularly powerful grip. Woodpecker legs are short but muscular, with strong toes tipped with long, sharp claws which give an effective hold even on the smoothest-barked trees such as beech.

Unusually for a bird, the toes are arranged with two pointing forwards and two back, (a condition called zygodactyly), which gives optimum performance on a vertical surface. Thus woodpeckers move vertically or often in a spiral up the trunk, and occasionally laterally. When they have finished searching for food on one tree, they swoop off to the base of another tree or branch and begin to ascend once again.

Woodpecker headaches? The most obvious wood-pecking adaptation is, of course, the beak. In the great spotted woodpecker this is relatively short, stout and sharp, with a squared-off end like a small chisel–an appropriate simile: rather than bludgeoning its way into the wood by sheer power, the woodpecker uses its beak as a combination of hammer and chisel, inserting the tip into the crack it has made and using its powerful neck muscles to twist the beak and prize off flakes of wood.

One obvious question relating to woodpeckers is: why don't they get splitting headaches? The answer lies partly in the robust

Below: A female great spotted woodpecker can be distinguished because it does not have a red nape patch like the male. Note the red under-tail covert.

bone structure of the skull, especially in front of the brain, and partly in a layer of shock-absorbing cartilaginous material that forms a cushion between the bones within the beak and the rest of the skull.

Long-tongued feeder The diet of the great spotted woodpecker is varied, and includes seeds, fruit and nuts. Nuts are often removed to a well-used cleft in a favourite piece of bark, and hammered open while they are held in position in this natural vice. Insect and larvae are another important food item. During winter these are often found sheltering under easily lifted flakes of bark; the great spotted woodpecker is also a specialist at extracting wood-boring larvae that have tunnelled into trees. The bird senses the approximate location of the grub, perhaps hearing minute sounds of movement or chewing. After a few swift pecks an opening is hacked into the tunnel, and then the woodpecker's enormously long tongue comes into play. In the case of the great spotted, the tongue can be extended for a couple of inches up the tunnel. The luckless grub is harpooned by the sharp, barbed horny tip of the bird's tongue, and dragged out to be eaten.

At rest the phenomenally long tongue is far too bulky to lie in the floor of the bird's mouth: a thickened tube runs out of the lower jaw, backwards beneath the hidden ears and then up the back of the head to the top of the skull. It is here that the tongue is retracted when it is not in use.

The natural all-year-round diet is augmented at various times by rather surprising items. The great spotted woodpecker has a marked taste for the nestlings of other birds, and is adept at catching them. As they grow, the nestlings of most hole-nesting birds, such as tits, alerted by the shadow of their parent falling across the hole, jump up to the nest hole entrance. Woodpeckers have capitalised on this: as their shadow falls across the hole a young tit jumps up to be the first to be fed, and the woodpecker reaches in and grabs it, dragging it out to hack up and eat on a more suitable perch. Sometimes woodpeckers learn to associate this food supply with nestboxes put up for tits, and they chisel their way through the back of the box to get at the eggs or young.

In rural and suburban areas from late summer through the winter great spotted woodpeckers are regular visitors to garden bird tables. They come particularly for fat, suet and peanuts. Even if the peanuts (or the fat) are suspended on a string, the woodpecker quickly cuts through it with its sharp beak, dropping the food to the ground where it is easier to eat.

Excavated nests Great spotted woodpeckers excavate their nesting chambers in the trunk or a stout branch of a tree. The nest is usually at least 3m (10ft) above ground. The entrance hole is circular and about 6m (20ft) in dia-

Great spotted woodpecker *(Dendrocopos major)*; 23cm (9in) from beak to tail. Common in both coniferous and deciduous woods in England, Wales, Scotland. Resident.

Lesser spotted woodpecker *(Dendrocopos minor)*; 14·5cm (5¾in) from beak to tail. Found in parks, orchards, gardens, copses, in England. Uncommon, but numbers have increased slightly in recent years. Resident.

Left: A male great spotted woodpecker at the nest of its young. Nests are made at least 3m (10ft) above the ground. The young birds have a red cap, like the adult male lesser spotted woodpecker.

Right: A cone cache collected by a great spotted woodpecker. The seeds form part of the bird's varied diet.

meter – slightly smaller and less oval with the green woodpecker and rather larger with the lesser spotted. A short horizontal tunnel leads to the pear-shaped nest shaft which is 25-30cm (10-12in) deep.

Each clutch is generally six, or fewer, beautifully spherical white eggs that are incubated by both parents in turns for 16-17 days. When they hatch, the youngsters are naked and noisy, and particularly ugly and reptilian-looking for small birds. They fledge in about three weeks, depending on the weather. There is normally one brood each summer.

Drumming for a mate The male advertises for a mate and later indicates the boundaries of his territory by drumming on an appropriately resonant, often dead, piece of branch. On occasion woodpeckers seek special effects by drumming on a corrugated iron roof. For many years controversy raged over how the noise was produced. Many skilled ornithologists argued that they could see that it was made vocally, much as we can 'roll rs' with our tongues curled. The issue was only settled in the 1930s by embedding microphones in regularly drummed branches, which showed that a rapid succession of physical taps by the beak against the tree caused the noise.

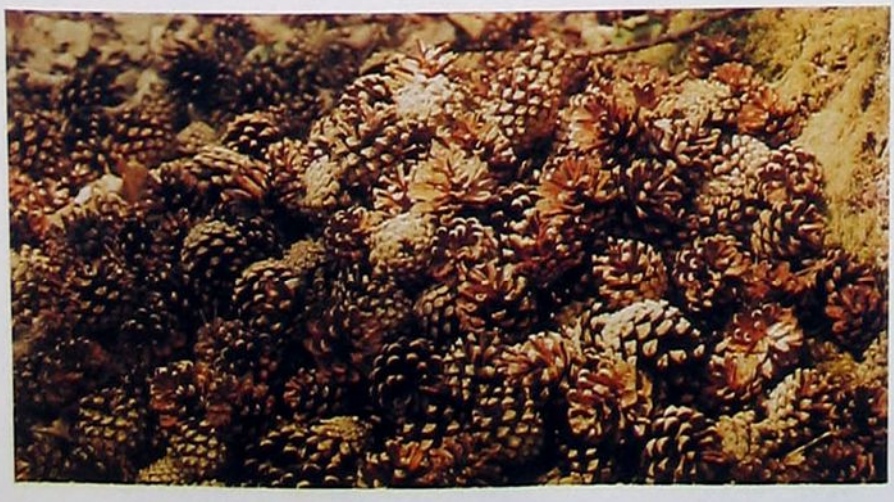
Above right: A great spotted woodpecker feeding its young on another fledgling. It also eats insects and their larvae, fruit and nuts.

Lesser spotted woodpecker

Compared with the short and powerful bursts of drumming of the great spotted, the lesser spotted woodpecker drums at a noticeably higher pitch and in drum-rolls lasting twice as long.

The lesser spotted woodpecker shares the pied, barred plumage of the great, although it lacks the scarlet beneath the tail. It is the smallest European woodpecker. The circular nest hole is only about 4cm (1½in) wide and the nest is usually situated on the underside of the dead branch. There are normally four to six white eggs, and incubation and fledging take much the same time as in the larger bird. The eggs are incubated by both the male and the female parent, and both birds also feed the nestlings.

The lesser lives in similar habitats to the great spotted, although it penetrates less into agricultural and urban surroundings other than in old orchards which it particularly favours. It is nowhere very numerous. Old county reports and Victorian bird books, however, indicate that in the latter half of the last century the lesser spotted was the commoner, the greater spotted the rarer woodpecker. It would be fascinating to know the reasons for the change. Perhaps they are similar to the causes of the current increase in lesser spotted woodpecker numbers. For some reason they seem to have profited particularly from the Dutch elm disease outbreak, feeding off the numerous insects that live beneath the dead bark and nesting in the rotting wood: at least some small benefit from the disease.



SMOOTH AND HYBRID ELMS

Apart from the English and wych elms, you can see four smooth elms, and also many elm hybrids, cultivars and clones, growing in various localised areas of the English countryside.

There are four species of smooth-leaved elms in the British countryside – the smooth elm, the Coritanian elm, the Cornish elm and the Plot elm, and a number of elm hybrids as well.

The smooth elm is so-called because it has leaves that are smooth on both sides. It is an erect tree, with a domed open canopy, and is much broader and more spreading than the English elm (see page 673). The long branches are ascending and sinuous, and the shoots are pendulous, particularly at the edges of the tree. The flowers appear in late May, which

Wheatley elm *(Ulmus sarniensis)*. Deciduous, native to south-east England, particularly by the coast.

is later in spring than those of other species in this group. The smooth elm is one of the most widespread elm species: it is a native of Kent and East Anglia and also of south and central Europe, south-west Asia and North Africa.

The Coritanian elm is also a spreading tree with an open crown and ascending branches. You can recognise it by the leaves which are leathery, markedly asymmetrical, bright green, shiny above and pale below, and hairless except for occasional tufts of hair in the leaf axils. Its name comes from the area around Leicestershire once occupied by the ancient Britons – the Coritanae – but it is actually known to have a sporadic distribution in East Anglia, Northamptonshire, Essex, Cambridgeshire and Nottinghamshire.

The Plot elm is named after a certain Dr Plot who wrote a 'Natural History of Oxfordshire' in 1677. He described a cultivated avenue tree with narrow leaves from Hanwell, near Banbury in Oxfordshire, which was later to become his namesake.

The Plot elm is a plume-like tree with arching, leading shoots and pendulous branches. It has very small leaves which appear to be smooth on both sides, although in fact they are lightly hairy. This species has the unique ability to produce proliferating short shoots with many small leaves that have less obvious teeth than other species. Today the Plot elm is extremely rare and is mainly found in the Trent Valley near Newark in Nottinghamshire and the Witham valley in Essex.

The Cornish elm often has a flat, wind-cut crown and in Cornwall is sculptured into a variety of shapes. The leaves are usually rather narrow, slightly leathery, somewhat concave and more or less folded. It is perhaps the most distinctive species of all the elms. Cornish elms are an important part of the west country skyline. Because many neighbouring trees have been felled, and the Cornish light is strong, many Cornish elms produce numerous shoots up and down the stems, giving the trees a clothed appearance.

Hybrid elms Although there are six important elm species in this country, most of our trees are in fact hybrids. Elms used to be widely planted, and there are many natural crosses, cultivated crosses, crosses between natural trees and introduced trees, and even hybrids between hybrids.

Without doubt, the most important is the so-called Dutch elm, which is a group name for a number of hybrids and clones derived from crosses between the Wych elm (page 674) and the smooth elms. Dutch elms are said to have originated in Belgium and are today found in England and various parts of Europe, but are, strangely enough, absent from Holland. They have the overall appearance of the Wych elm, but are usually larger, with a more open crown. They have large leaves like the Wych elm but without the 'ear' at the base. Two cultivars, 'Hollandica' and 'Vegeta' are widely planted in southern England. 'Hollandica', which can be distinguished by the corky, flanged, stems of the suckers, is a victim of Dutch elm disease.

One of the most interesting complex hybrids is the Jersey elm, a fertile hybrid between the hybrid Dutch elm and the Cornish elm which has the characters of four different species. It has a conical crown and although it looks similar to the Cornish elm it is less prone to sculpturing by the wind. Because of its attractive shape it is highly favoured as a park and avenue tree. It has a more easterly distribution than the Cornish elm and occurs in south-east England and north-west France.

Above: Cornish elm *(U. angustifolia)*. Deciduous, native of the West Country.

Elm wood

Because so many elm trees have been cut down as a result of Dutch elm disease, elm wood is now plentiful and has come back into fashion. It has been used for centuries: the furniture industry, based at High Wycombe, favoured elm for pieces that needed to be pinned or glued. Elm timber has been used where heavy solid wood is required. The marine trade particularly finds it useful because it does not rot below water. The keels of wooden boats, piles for wooden bridges, lock gates, and today, the centre board in the hulls of wooden narrow boats are all built of elm. Despite a glut due to Dutch elm disease, elm does not have as wide a usage as it perhaps could. The best woods are used in veneers on chipboard, kitchen fittings and coffins, and the trees that do not form perfect timber are sent to factories to be pulped for brown paper manufacture.

Smooth elm *(U. carpinifolia)*. Deciduous, native in southern England.

Coritanian elm *(U. coritana)*. Deciduous, native in eastern areas of England.

Plot elm *(U. plotii)*. Deciduous, a rare native of Trent and Witham valleys.

Dutch elm *(U. x hollandica)*. Hybrid, widely planted in southern England.

HOUSEFLIES: THE SWARMING HORDES

Many households are troubled in autumn by swarms of flies that come inside to hibernate. Thousands of these insects congregate in roof spaces and other crannies and, on a warm winter's day, may wake up and start buzzing around the room.

Bluebottle fly *(Calliphora vomitoria)* on a flowerhead. Although blowflies of this, and other species, cause meat to become 'fly-blown', they are useful to man because they dispose of carrion.

Many flies enter houses, but only one is the true housefly, *Musca domestica*. This fly is about 6mm ($\frac{1}{4}$in) long, mouse grey in colour and with a 'definite' flight from one place to another. It can be found everywhere in the world, always living in close association with man.

Houseflies belong to the large insect group the Diptera or 'two wings', all of which have only one pair of flying wings. The hind pair are reduced to knob-like organs called halteres, or balancers, which help to maintain steady accurate flight. The Diptera also include midges, gnats and craneflies.

Breeding cycle Houseflies breed in a variety of moist and putrefying substances. Fresh horse dung is preferred but other dung, especially pig or exposed human faeces, are also chosen. Nowadays such dung is inaccessible in cities; here flies breed in municipal refuse tips or other large accumulations of decaying organic material.

The female housefly lays eggs in batches of 100 to 150, in crevices in the dung. In a life of about one month she can lay four or five such batches. The eggs hatch within a day or two and the larvae, which do not have a proper head and are called maggots, burrow into the warm mass, choosing a zone with a temperature of 45-50°C (113-122°F) if possible. Here they feed for about a week, moulting three times. At lower temperatures they take longer to mature.

When full-grown the maggots burrow into

loose soil to become pupae, enclosed in pupal cases formed from their hardened, barrel-shaped last larval skin. After a further one to three weeks, according to temperature, the adult fly emerges by splitting off a circular cap at the front end of the pupal case, using a special inflatable part of its head called a ptilinum. The fly also uses the ptilinum to work its way out of the soil. At this stage the fly's wings are crumpled, but once it emerges from the soil they are pumped up by blood pressure.

The housefly does not seem to have a well-established hibernation stage, but breeds throughout the warmer summer months, its numbers reaching a peak in autumn. After October most flies die and active adults are seen only in heated buildings. The species is maintained through the winter by slow breeding in fermenting rubbish dumps or in farm livestock sheds.

Food contamination Houseflies generally stay within a mile or two of their breeding site, seeking out human habitations for food and new breeding sites. This is where the danger of food contamination lies, because they fly directly from food to breeding place and back again. They vomit on to the food to soften or liquefy it and, at the same time, defecate on it, causing considerable contamination. Oddly enough, it seems that the fly's faeces are the main source of danger to man, not the huge number of bacteria on the fly's body which appear to dry up readily.

Diseases which houseflies can transmit include infantile summer diarrhoea, typhoid fever and many other intestinal infections and, in warm countries, eye infections. In addition, flies can pass on the eggs of parasitic worms that they have picked up while feeding on faeces. It is therefore very important to take every precaution to prevent houseflies from settling on food.

The lesser housefly (*Fannia canicularia*) is probably one of the commonest flies in houses in the British Isles. It looks like a smaller edition of the true housefly, but you can tell the two apart – at close quarters – by the veins in the wings. The vein near the

Walking on walls

People often wonder how houseflies can walk up highly polished surfaces. Between the claws on a fly's foot there are sticky pads that enable it to hold on to almost any surface – glossy painted walls, wallpaper or a plastered ceiling – even when it is vertical or upside down. Landing on the ceiling is another intriguing manoeuvre that presents no problem to the housefly. It performs this by stretching out its legs and doing a half-roll turn. The sticky pads on the feet then hold it firmly in place, and it can walk about upside down without falling off.

Housefly *(Musca domestica)*. Mouse grey in colour. 6mm ($\frac{1}{4}$in).

Lesser housefly *(Fannia canicularis)*. Smaller than housefly.

Bluebottle *(Calliphora vomitoria)*. Bright metallic blue.

Greenbottle *(Lucilia caesar)*. Metallic green in colour.

Autumn fly *(Musca autumnalis)*. Similar to housefly.

Cluster fly *(Pollenia rudis)*. Holds wings flat on its back.

Below: Greenbottle fly *(Lucilia caesar)*. Note the brilliant green, shining body and the black hairs on the abdomen.
The larvae of greenbottles are sometimes present in the soil around houses and can be forced up out of the soil in alarming numbers after a heavy rain storm.

Right: Greenbottle and bluebottle flies on a dead chick. They lay their eggs on carrion such as this.
There is a common fallacy that the smaller flies grow into larger ones. This is not true: winged insects are adult and will not grow any bigger. Smaller flies are simply different species.

Left: The flies shown here are only the more obvious and common species of those that enter houses. There are many other species.

middle of the wing in *Musca domestica* bends sharply forwards, while that of *Fannia* is straight. The flight of *Fannia* is 'indefinite'; these flies often circle around light fittings.

Fannia lays its eggs in moist decaying organic matter and can be troublesome near poultry houses where it breeds in the large accumulations of chicken droppings. Its habits differ from the housefly, the females spending more time near their breeding places. The flies indoors are largely males. The maggots have a number of tail-like processes on each segment. As these flies are not attracted to man or his food, they are much less dangerous than the housefly.

Blowflies You can tell when warm weather has arrived by the blowflies–bluebottles (*Calliphora*) and greenbottles (*Lucilia*)–that start buzzing noisily in and out of the house. They are looking for meat and fish on which to lay their eggs.

Bluebottles, shining blue in colour, are about 11mm (½in) long, while greenbottles are greenish and slightly smaller. They lay five or six batches of up to 200 eggs each in crevices in meat or carcases, and the resulting maggots (fishermen's 'gentles') liquefy the flesh with their saliva so that they can feed on it. They take about one week to become full grown, and then pupate in the soil or in some suitable crack. Another week or two sees the adult flies emerge.

Blowflies are heavily contaminated with bacteria picked up from carrion and garbage, but since they are mainly interested in raw meat, any bacteria they transmit are usually killed by cooking. They do, however, spoil meat, which becomes 'fly-blown'–full of maggots. In urban districts they are particularly common near slaughter-houses and around butchers' shops.

Above: Male and female autumn flies (*Musca autumnalis*). This species is very similar to the true housefly, but does not associate with man, being found in fields with horses and cattle, in the dung of which the larvae feed.

Right: Blowfly pupal cases are characterised by their hard covering and barrel-like shape. The adult flies hatch in one to three weeks, according to the temperature.

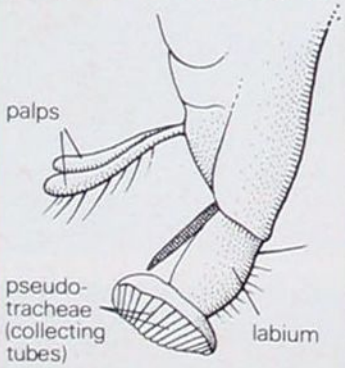
Greenbottles have developed a particularly unpleasant habit of laying eggs in the soiled and matted wool at the hind end of sheep. The maggots eventually infest the flesh of the sheep, eating it away. This attracts other blowflies and may result in the death of the sheep, causing much loss to farmers.

Autumn swarms Four or five principal species enter houses in swarms in autumn, but the best known are the autumn fly (*Musca autumnalis*) and the cluster fly (*Pollenia rudis*). The autumn fly looks very similar to the housefly, but in the summer frequents fields, not houses. Its larvae feed on the dung of livestock such as horses and cattle. The cluster fly is slightly larger than the autumn fly, and holds its wings flat on its back; its larvae are parasitic on earthworms.

It can be extremely alarming to enter a room in the autumn and find the walls and furniture covered with thousands of flies. When the light is switched on they tend to fly about, which is even more frightening. The only thing to do is to spray with insecticide and sweep up the bodies.

In the autumn these flies tend to collect on the outside of buildings, on the sunny side, and as the nights get cooler they make their way into roof spaces, under tiles and into bedrooms, forming clusters of many thousands of individuals.

How houseflies feed



side view of proboscis

Flies feed on anything sweet and moist, especially milk, meat, excrement and garbage. (Protein rich food is needed by the females for egg production.) They have the habit of vomiting on their food to soften or liquefy it. This is repeated several times, both on human food and dung and refuse. At the same time they defecate, perhaps every few minutes, leaving dark spots (see the greenbottle fly, *Lucilia caesar*, above right) so that the total contamination of food can be considerable.

Houseflies, like all Dipterans, feed by sucking up the food they have liquefied with a specially adapted fleshy proboscis (above left). This has many little tubes, called pseudo-tracheae, at the tip.

RICH RESERVOIRS

Britain's huge above-ground reservoirs – built to supply cities with water – have also provided a rich new wetland habitat where wildlife can thrive.

Our modern society expects – and gets – pure water supplied to every home and factory in the land. We accept this unquestioningly, use the water, and probably think little of how it reaches us. Water – readily and instantly available in extremely large quantities – comes to us in some cases from underground

wells and natural storage chambers in the rock, but increasing amounts are now being held in above-ground reservoirs. These catch and retain the flow of streams and rivers, or have water pumped into them from other sources. Nearly all our larger cities and conurbations of people have drinking water reservoirs not too far away.

Water is attractive to all forms of wildlife. Even the smallest garden pond quickly becomes the home for pond-skaters, water-beetles and even frogs, and garden birds come to it to drink. Enlarge that pond many times over and other birds arrive to bathe and swim, plants begin to colonize the water and its banks, insects and other invertebrates fly in, or come down the feeding streams, and before long a whole rich wetland habitat has been created. This is exactly what happens when a new reservoir is built; most reservoirs eventually become havens for birds, fish, insects and plants, though this was far from the minds of the engineers who constructed them.

Types of reservoir Reservoirs can be divided into three main types, which have varying attractions for wildlife. There are upland waters, sometimes completely artificial, but often natural lakes that have been dammed up to increase the depth of water. Secondly, many of the reservoirs near towns and cities are sited on fairly flat land, with earth banks built up and lined with concrete to retain the water and increase the capacity. Thirdly, there are the more natural lowland reservoirs, with a concrete dam at the end of a shallow valley that traps water draining into it. These last are easily the most attractive to all forms of wildlife.

Habitat for the hardy The upland waters of Britain, in the Lake District or Scotland, form a severe habitat in which only the tougher species of wildlife can survive. The underlying rocks are acid and so do not add much fertility to the water. Plant and insect life is often sparse as a result; so, too, are the numbers of birds that live on them. This is as true of reservoirs in these areas as it is of natural waters. In addition, many upland reservoirs are subject to considerable fluctuations in water level. Water is pumped in or out in large quantities and several feet of mud and rock may be exposed from time to time. These changes are unpredictable, so there is not much chance of plants becoming established around the banks. However, if mud is exposed for a season, a single species of pioneer plant–thistles or purple loosestrife, for instance–can become established on the banks.

Gradual enrichment The lack of natural shores in concrete-lined reservoirs inhibits the growth of plants, most of which need shallow water and shelving banks. The water does not, however, remain sterile for long, provided it contains some natural goodness

Opposite: Craig Goch Reservoir, Elan Valley, in Wales. An alien fish, the American brook trout *(Salmo fontinalis)* was introduced to this reservoir, and many others, in the late 1970s–mainly for the benefit of anglers–and is thriving.

Below: Purple loosestrife *(Lythrum salicaria)* growing in spiky purple masses on the banks of Dowdeswell Reservoir in Gloucestershire. The lack of natural shores in concrete-lined reservoirs inhibits the growth of plants, but if there is sufficient soil on the banks pioneer plants such as loosestrife and thistles soon establish themselves.

from the surrounding soil. Quite a number of plants can live in water without being rooted. The tiny green leaves of duckweed and frogbit form extensive mats floating on the surface and the plants obtain nutrients directly from the water with their many fine rootlets that hang underneath the leaves. The rafts of vegetation often form floating homes for small snails and other animals.

Although the bottom of the reservoir probably starts off as hard-packed earth, it gradually acquires a layer of silt in which other plants can become established. Pondweeds of several different species, including the introduced Canadian pondweed, water milfoil and water lilies are all bottom-rooted but send up leaves and flowering spikes to the surface.

Invertebrate life will arrive and colonize any stretch of water, but most kinds flourish only when there are enough plants there to provide food and resting places. The larvae of many flying insects – midges, damselflies and mayflies – all live in the mud at the bottom, or on the underwater parts of plants. Water boatmen, water-beetles and many different kinds of snails swim and crawl among the vegetation and pond-skaters and whirligig beetles scurry over the surface. All these plants and animals are food for birds; once they are established, then the birds arrive to feed on them. A barren area may be used by birds as a roosting place, or for drinking and bathing, but if there is plenty of food available, large numbers of birds begin to use the reservoir regularly. Some of the concrete-lined drinking water reservoirs in West London, near Heathrow Airport, hold the largest flocks of tufted duck and pochard in the country, often being thousands strong. Both species of duck feed by diving for plant leaves and stems, small snails and other underwater animals. Coots also feed in this way and large flocks of them can be seen on many urban reservoirs.

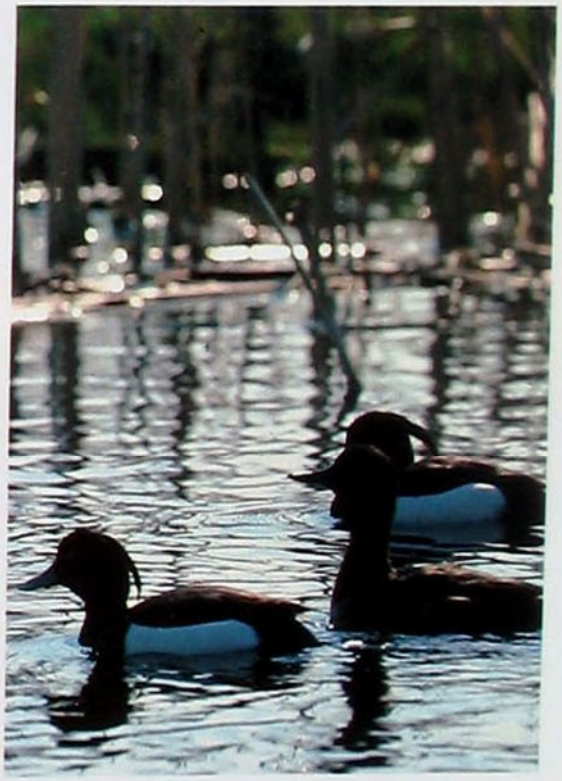
Lowland reservoirs There is no doubt that the lowland valley reservoirs, particularly those in southern England, are the richest for wildlife. The greater pond sedge and the beautiful flowering rush form dense stands, together with the familiar reed mace. They extend from the shallow water up the natural banks on to dry land where they mix with willowherbs and water dropwort. If the area is left completely alone, willows and alders will appear, eventually producing woodland.

The plants provide food, shelter for insects and nesting sites for many small birds as well as the ducks, coots and grebes. Some fairly large reed beds exist on a few reservoirs, while in shallow water, emergent vegetation creates virtual islands.

The water flowing into these reservoirs from the streams is rich in nutrients such as nitrogen and phosphorus. Much of this comes from the natural fertility of the soils of lowland Britain. More is added by farmers to fertilise their crops, the surplus being washed out by rain and eventually finding its way to the reservoirs. In excellent conditions such as these, plants flourish, the tiny plankton and algae in the water proliferate, and a considerable richness and diversity of wildlife builds up.

Wildfowl counts Numbers of birds on the lowland reservoirs, particularly the ducks, reflect the abundance of food. There are many reservoirs that hold several thousand ducks each winter, of many different species. Several of our larger reservoirs, for example Chew Valley in Avon, Blithfield in Staffordshire, Grafham Water in Huntingdon, and Rutland Water in Leicestershire, are visited

Above: Gulls flying over Lliedi Reservoir in Wales. Gulls frequently roost on reservoirs at night, bathing and drinking on their arrival in the evening, but not feeding there. They probably spend the day taking insects from playing fields and parks, or scavenging on rubbish tips. You can also see thousands of swifts flying over reservoirs in summer, hawking for insects over the water.



Above: Tufted duck *(Aythya fuligula)*. The reeds and other waterside vegetation found in lowland reservoirs with natural banks provide food, shelter for insects and nesting sites for the ducks, and for other birds such as coots and grebes.

Rutland Water, a new reservoir in Leicestershire, is the largest man-made reservoir in Britain and is an excellent example of how the interests of wildlife and recreation can be met in the same place. It is shaped rather like the letter Y. Most of one arm, and the top of the other, have been made into a nature reserve, planned even before the dam was built and flooding began. Fishing and sailing are catered for on the remaining part of the reservoir—so all interests are satisfied. Within two years of flooding, Rutland Water was carrying larger numbers of wintering wildfowl than almost any other reservoir in the country and mammals such as the fox, badger and even deer were established in the nature reserve.

by large numbers of birds every winter.

Wetlands of all types in Britain have been rated according to the numbers of wildfowl that visit them regularly. If a water holds more than 1% of the national total of a particular species, then it is rated as of national importance to that species. On this basis several reservoirs are of national importance, for tufted duck, shoveler, pochard, mallard, wigeon and teal. One reservoir, Abberton in Essex, though partly concrete-banked, regularly holds over 10,000 ducks of different species, and this qualifies it to be rated as of international importance as a wetland site, comparable to waters throughout Europe and further afield.

Policy change Until fairly recently, people were not allowed near the majority of drinking water reservoirs. The authorities concerned were worried about safety and health risks. Fishing was permitted at just a few reservoirs, usually for trout which were reared and put into the water for the purpose. At other sites, birdwatchers were allowed to visit in small numbers, but any other kind of recreation was prohibited.

This attitude has now been completely relaxed, and various sports—especially sailing—are encouraged. This is not always compatible with the wildlife of the reservoir; many species are frightened off by boats on the water, and fishermen lining the banks trample vegetation and disturb nesting birds. Even walkers can discourage wildlife.

When reservoirs were opened up for recreation about ten years ago, there was no doubt that the value of some of them for wildlife was seriously diminished. More recently, however, there have been a number of successful schemes for fitting both recreational and wildlife interests into the same reservoir. For example, at Chew Valley in Avon the area within which the sailing boats can operate is strictly limited, as is the total number of boats permitted on the water at any one time. The boats are not allowed into the shallow areas and sheltered bays that are the preferred spots for the water birds and which have the best growths of plant and animal life.

Substitute habitat

The drinking water reservoirs created by man for the purpose of supplying water in large quantities to towns and cities also benefit wildlife greatly by providing a new habitat for plants and animals to colonize. However, it is ironical that, at the same time as creating this new habitat, man has been trying to rid lowland Britain of almost all its natural freshwater wetlands. Marshes have been drained, rivers straightened and embanked to prevent winter flooding, and even large numbers of small ponds have been filled up. The building of the reservoirs has not, of course, been a deliberate replacement for all the destroyed wetlands, but it has been at least some recompense and substitute for them.

LONG-BILLED SUPER SNIPE

Snipe, noticeable for their long, straight bills, are small wading birds most often seen in inland marshy areas, damp meadows and river valleys.

The two species of snipe regularly seen in the British Isles are both birds of rank vegetation in damp, fresh-water areas. Both birds have richly mottled and striped brown body plumage, with characteristic creamy stripes along each side of the back. The jack snipe is known only as a winter visitor and is the smaller of the two species, with a shorter beak. The common snipe is a widespread breeding species, and its numbers are augmented during winter by an influx of larger birds from the rest of Europe; it has a very long bill.

Common snipe breed in damp meadows, river valleys, coastal fresh-water marshes, bogs, and over damp moorland throughout the British Isles. They are thinly scattered in the more populated areas of south-eastern England but become increasingly common in western and northern Britain. There are particularly large breeding populations in the boglands of central Ireland, over much of the Highlands of Scotland and on many Scottish islands, especially the remote St Kilda group. The birds are quite small–roughly the size of a starling, but look much longer as they have 6cm (2½in) long bills.

'Drumming' flight It is easy to discover that common snipe are holding territory, as the birds have a conspicuous aerial display called 'drumming'. The displaying bird flies above its territory, periodically swooping down with its outer tail feathers pushed out into the passing airstream. The feathers are strengthened and stiff so that they whirr as the air passes them, causing the 'drumming' sound. In fact, to most people the sound is not so much a drumming noise as a bleat, sounding rather like a goat. Such displaying birds also utter a 'chippering' note.

These noisy displays may take place at any time of day but are most usual early in the morning or during the evening; some birds display at night as well if there is a bright moon. There is another territorial call, generally given from an elevated perch such as a fence post or tree stump, and this is a sharp, loud 'tock'.

Territorial displays may take place as early as February in southern England–at

The jack snipe is a winter visitor that breeds in the north-eastern parts of Europe and western Siberia. It is smaller than the common snipe but less shy; if approached it does not fly away until the last possible moment.

Jack snipe
(*Lymnocryptes minimus*), 19cm (7½in) from beak to tail. Shorter bill and rounder wings than common snipe and no white on tail. Sept-April visitor.

Common snipe
(*Gallinago gallinago*), 27cm (10½in) from beak to tail. Very long bill. Resident.

Above: Common snipe feeding in marshland – their typical habitat. You usually see them in groups, probing with their exceptionally long bills for worms and other food. They also take insects from the surface.

least two months earlier than the displays of birds in northern Scotland.

The snipe makes its well-concealed nest on the ground (see photo captions, page 743). The chicks are most attractive, with striking markings. They are able to fly after 18-20 days but, like all waders, they leave their nest within a few hours of hatching. In some areas two broods may be reared, but most pairs are thought to be single brooded.

Long sensitive bills The common snipe's long bill is used to obtain food from deep in the ground. It is a precise and sensitive tool and a bird can insert the whole length of the bill into soft ground and still open the tip to take worms or other food. Snipe take food items from the surface as well.

When the marshy areas where snipe normally feed freeze rock hard, they are adept at finding areas which have not frozen, such as where a spring has kept the ground open. Here they may congregate in large numbers. Flocks of snipe, known as wisps, flushed out from the marshes by shooting parties, usually number fewer than 10 birds, but in freezing weather favoured areas might provide flocks of 50-100 birds. If frosts persist native birds may be forced to move to Ireland, where it is generally warmer in winter, or southward to France or Iberia.

Worldwide distribution The common snipe is a widespread species away from the British Isles. The main population breeds right across northern Europe and northern Asia, and another group occupies most of South America; there are even common snipe breeding over much of East Africa. Some of the island populations, such as those on St Kilda and other outlying Scottish islands, are slightly bigger and darker than the general run of British and European birds. The birds in the Faeroes and Iceland are certainly big and dark, and it is probably the influence of the island's isolation which causes these differences in colour and size.

The jack snipe is much rarer than the common snipe and is a native breeding species of the north-easternmost parts of Europe and western Siberia. The wintering birds reach the British Isles in October and leave again in March or early April. The birds are superficially similar to common snipe, but their bills are shorter and they are, overall, about two-thirds the size of the common snipe. Their choice of habitat is much the same, but they allow a closer approach, and when they fly off they do not

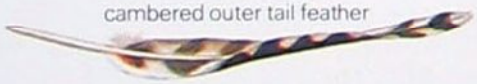
Left: When flushed out of the vegetation in which it hides, the common snipe twists as it rises steeply away, but the jack snipe flies slowly in a broad loop and usually for a shorter distance.

usually call or 'jink' in flight. Indeed, they often pitch again within a few dozen yards. They are quite often found along the edges of paths or ditches in marshy areas, and may sometimes be in small flocks – especially shortly after they have just arrived in autumn on the east coast.

The great snipe is the only other snipe found regularly in the British Isles. A handful is recorded each winter as visitors from the breeding areas of north-east Europe. They are difficult to distinguish from the common snipe, although they are actually plumper and show more white on their tails in flight. The great snipe is the long-distance migrant record holder for the group. Many are recorded in Africa in winter.

Fair game All snipe are liable to be shot during autumn and winter, both in the British Isles and in other European countries. Game species such as pheasants and grouse are shot in a highly organised fashion, but most snipe are shot by people walking through marshland, accompanied by dogs. The birds are disturbed as they rise and jink away. They

Common snipe



The superbly marked fluffy chicks (above), the eggs (right), and a newly hatched egg being guarded by a parent (below), of the common snipe. The nest is usually made within a grassy tussock in freshwater marshy surroundings, and four eggs are laid. Like those of most waders, the eggs are pointed with dark blotches on an olive background. They are incubated for 20 days by the female alone. When the chicks hatch, their basic ground colour is dark, rich chestnut, spangled with gold and silver markings.

are always difficult to kill, and at present there is no evidence that the population is suffering through shooting. Indeed, there are records of much more intense shooting pressures in the past than now. Drumming birds are, of course, safe from being shot as they display only during the close season, which starts at the beginning of February and lasts until 11 August.

However, it is not possible to be complacent about these birds and their chances in the future as their habitats are under increasing pressure. In southern Britain areas of marshland are being drained and taken into arable agriculture, and many of the smaller field ponds that in the past provided shelter and food for one or two birds during winter have been filled in. Old-fashioned sewage farms, with their large settling ponds with muddy margins, have been replaced by systems with little, if any, chance for snipe to feed. As fresh-water wetlands are drained, what are now commonplace birds could become rare over the span of just a few decades.

CUNNING CARP

The carp, an introduced fish, is found mainly in the warm, sunlit lowland waters of the British Isles. Once purely a food fish, this cunning fighter has become an exciting challenge for anglers everywhere.

Above: The mirror carp is irregularly covered with large scales.

No one knows exactly when the carp was introduced to Britain, but it was certainly long before people kept records of fish they caught. Carp bones have been found in Greece and along the Danube in very early prehistoric settlements and were clearly native to these areas. The original distribution of the carp was in the basins of the Black and Caspian Seas. From the Black Sea, it travelled westwards along the Danube into Austria and Germany, spreading into the Rhine and the Elbe, and from there throughout western Europe. Its spread was assisted by its tenacity. Out of water, the carp is very passive and it will survive for many hours in baskets or sacks packed with wet straw, allowing it to be transported quite freely.

Introduced carp The point at which the carp arrived in England has often been discussed. The doggerel lines 'hops and turkeys, carps and beer, came into England, all in one year' although interesting, unfortunately do not provide a firm date for the carp's introduction, as none of the other items can be accurately dated. Other evidence is fragmentary and often conflicting. In 1279, the feast prepared to celebrate the enthronement of the Archbishop of Canterbury is said to have included 100 carp, which seems to indicate that it was present in fair numbers by that date. On the other hand, William More, Prior of Worcester from 1518 to 1536, who kept careful records of the fishes introduced into his stockponds, did not stock carp until 1531, and then only on a small scale. The evidence, although rather confused, does seem to indicate that until the 1600s carp were stocked as a food fish in the fish ponds of monasteries and land owners, but were uncommon elsewhere.

Below: The slender wild carp (*Cyprinus carpio*). Pond-bred or cultivated carp tend to have deeper bodies and higher backs.

The range of carp in Britain today is heavily dependent on where it was stocked in previous centuries as a food fish, and in the 19th and 20th centuries for angling purposes or as an ornamental fish. It is widely distributed in the British Isles but is common only in lowland England. It is virtually absent from Scotland, apart from a few lakes in the lowlands.

Typically an inhabitant of still waters, the carp is usually found in ponds and lakes, but substantial numbers live in slow-flowing lowland rivers with muddy bottoms and plenty of vegetation. These river carp tend to be more slender, athletic-looking fishes than their pond-dwelling cousins, bearing more resemblance to the wild carp of the Danube and other Black Sea rivers. Paradoxically, the race of wild carp of the great rivers of Europe and Asia has become almost extinct, being overtaken by the mass of selectively bred carp from fish farms in all the inland countries.

Temperamental reproduction An important natural factor which has affected the carp's success in our country is temperature. A warm water fish, it requires temperatures of 18 to 20°C (64-68°F) in which to spawn. Relatively few lakes in Britain attain temperatures as high as this in late spring, the carp's spawning time, and as a result it breeds successfully each year in only a few waters. However, the carp is a relatively hardy fish and can live in ponds with an average summer temperature of between 15 and 18°C (59-64°F), although it will not spawn at these levels.

The wild carp

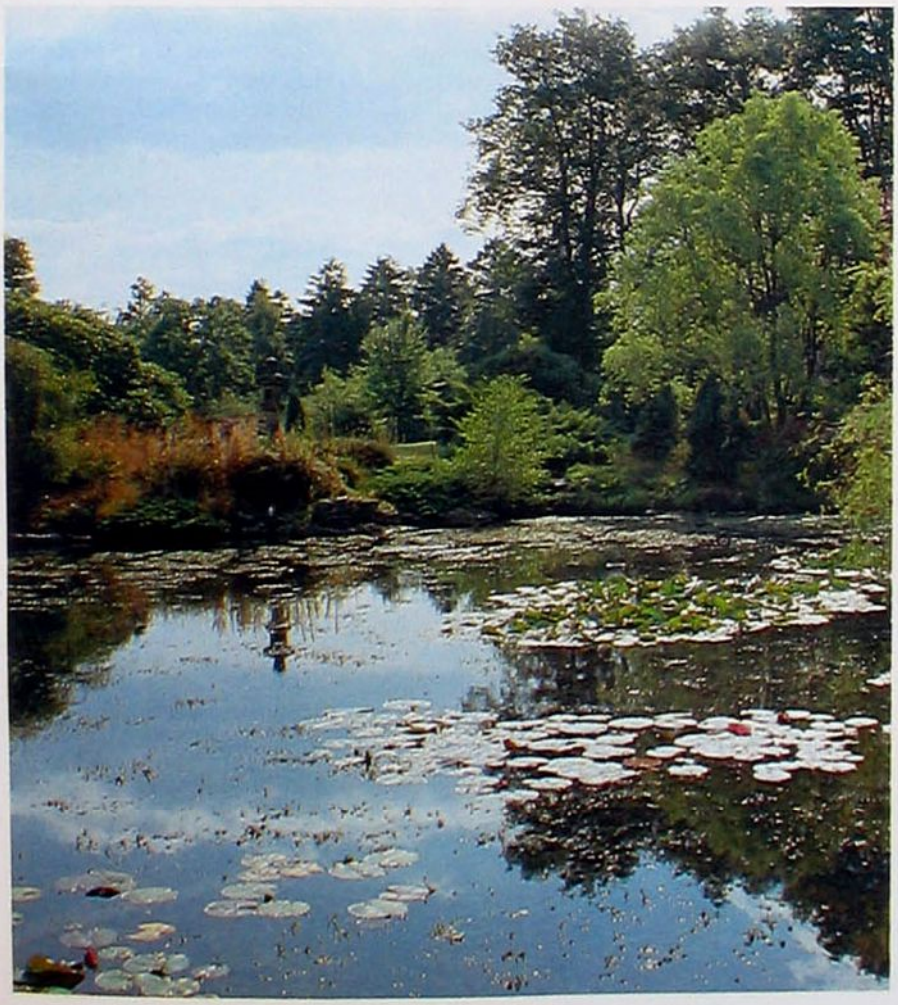
When the temperature is high enough for spawning to take place, the eggs are shed on plants such as *Potamogeton* and *Myriophyllum* in shallow water, and sometimes on the stems of reeds at the water's edge. The eggs are very small and yellowish in colour. They hatch in three to eight days, depending on the temperature. This is best expressed as about 100 day-degrees Centigrade, for example five days are needed at 20°C (68°F). The newly hatched larvae have a yolk-sac and attach themselves to the plants on which they hatched. Two or three days after hatching, they rise to the surface and fill their swim-bladders with air. After this, they become more active, feeding on microscopic algae, rotifers and small water-fleas. The carp also crossbreeds with the crucian carp, which is actually a different species, producing hybrids which are hardy, but sterile.

Foraging fish As the carp grows, it extends the range of its diet, taking bottom-living animals such as the blood-red midge larvae, snails, insect larvae generally, and plants. During summer it forages in mid-water and near the surface, eating considerable quantities of plant material. In winter, it retreats to deep water where it feeds much less. If the water temperature falls below 5°C (41°F) it stops feeding altogether. In cold winters it hibernates in deeper water.

Growth is very variable and again depends very much on temperature; below 13°C (55°F) growth slows down markedly. In carp ponds, where fast-growing strains are kept and fed regularly, a weight of 1kg (2lb 3oz) is attained in the third year of life. As these fish are usually marketed at about this size, they are rarely allowed to grow larger. In the wild, however, it often takes five years or more before they reach this size, although, given time, they will grow considerably larger. In 1980, an angler caught the largest carp ever taken on rod and line in Britain–a fish weighing more than 22.65kg (50lb)–although still larger fish have been caught in Europe.

Top: The body of the leather carp is usually scaleless, but it sometimes has one or two scales close to the dorsal fin.

Below: The ideal conditions in a carp pond are shallow water, a muddy bottom, not too much shade from trees and plenty of sun. The lily pads provide hiding places for the fishes.



Many of the waters which contain carp only do so because they have been stocked by angling clubs and individual anglers. Perseverance is required to catch carp, and they are popular because of the fight they put up when hooked. These fish–especially the large specimens–are actually rather difficult to temp with bait. As a result of this, anglers tend to put large quantities of ground bait into the water to attract the fish to the vicinity, ensuring a plentiful supply of food for carp in the popular waters.

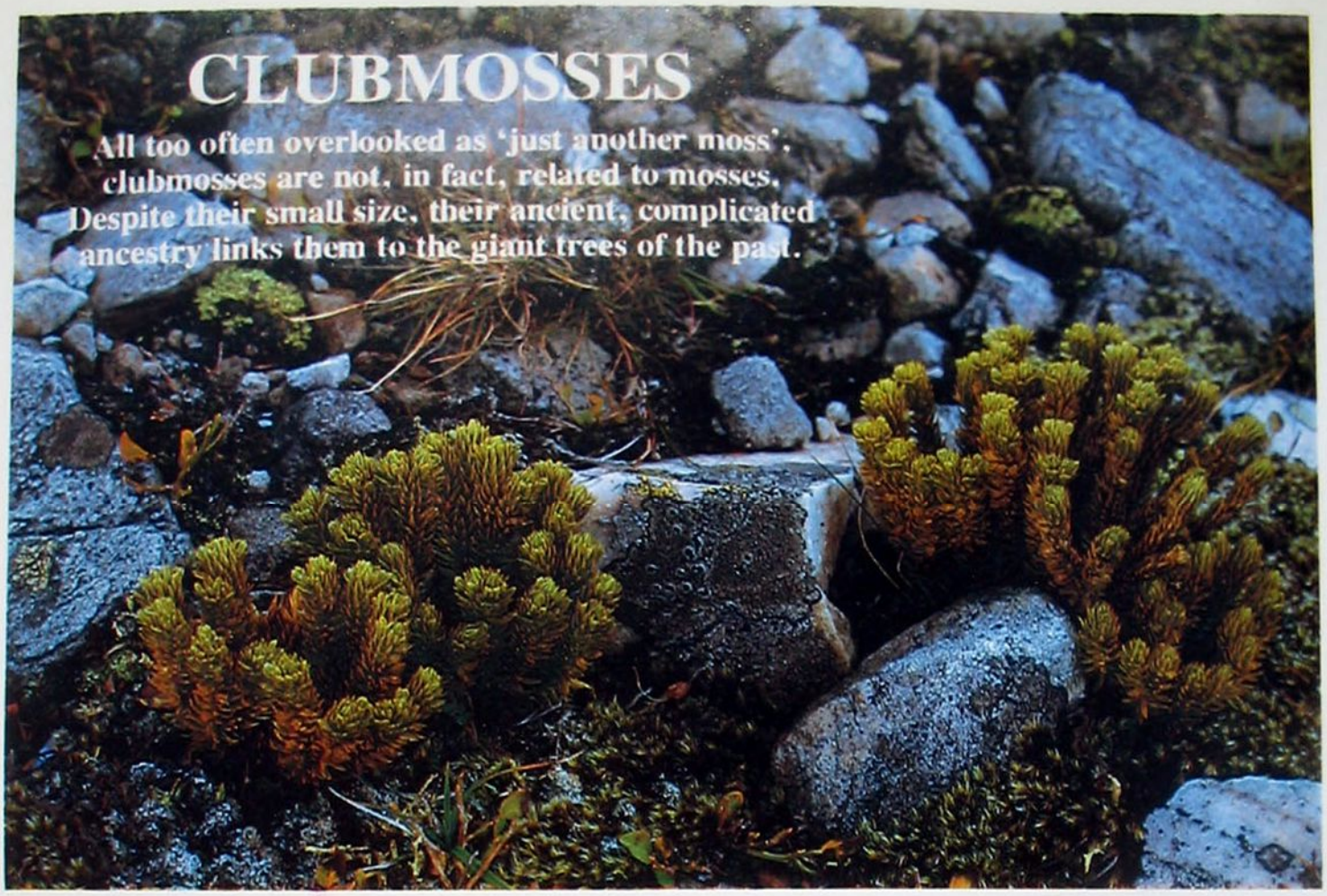
Selection of species The carp's history of semi-domestication goes back at least a thousand years. More than any other fish it has been modified by selective breeding in carp ponds. Over the years fish farmers have produced many varieties, bred from the slender-bodied, fully scaled carp of the rivers of the Black Sea basin. The fully scaled carp are usually known as king carp or wild carp (although they are deeper-bodied than the true wild carp). Mirror carp have a row of scales along the back and large scales scattered along their sides, the rest of the body being naked, like the leather carp.

All these varieties were bred originally as food fishes, their scale patterns cultivated to appeal to regional taste.

The koi carp–not to be mistaken for a goldfish which is an entirely different species–has been bred for other reasons. It is purely an ornamental fish with patches of colour varying from reddish-gold to blue-black, yet still retains features in common with the wild carp, such as the four barbels around the mouth.

CLUBMOSSES

All too often overlooked as 'just another moss', clubmosses are not, in fact, related to mosses. Despite their small size, their ancient, complicated ancestry links them to the giant trees of the past.



During the Carboniferous period 280 million years ago the vegetation was dominated by large trees, such as the giant *Lepidodendron* tree ferns. These massive plants, which often reached 92m (300ft) in height, had large trunks and branches that were divided into two, each branch ending in a huge cone. Pieces of these branches particularly the stem with its characteristic overlapping scales, are still found today as fossils.

Tiny descendants It is rather a shock to find that the living descendants of these plants actually look more like mosses, rarely growing above 15cm (6in) in height. These plants are called clubmosses but, despite their name, they are not actually mosses. They contain woody tissue, and well-defined structures for conducting water, mineral salts and food material, which are not found in mosses. Clubmosses are usually allied with ferns, but they are not really closely related to these either. The clubmosses differ in having leaves and spore cases which grow on the upper side, rather than the under side of the leaves. They really have more in common with the horsetails (see page 484).

Structure Clubmosses, which are green all year round, are usually creeping plants, although the fir clubmoss is upright. Most have branched stems, densely packed with small pointed leaves but Alpine clubmoss has broader leaves that clasp the stem like overlapping scales. Each leaf is a simple structure, with a single vascular strand running down the middle, giving support and conducting water. Creeping clubmosses root at several points as they grow along the ground. The plant branches regularly, usually forming two equal-sized branches at each point. Both, or only one, of the branches can grow, resulting in either a creeping mat, or in the plant growing in more or less a straight line.

Cones of spores In the summer, the clubmoss bears small cone-shaped organs of reproduction. These may be held aloft on modified stems, or borne along the ground. Clubmosses share with ferns and horsetails a process known as alternation of generations. This means that the plant has two distinct phases of reproduction, sexual reproduction taking place in the second phase. During the first phase the plants produce cones that are actually specialised structures of closely packed leaves. On the upper surface of these leaves, there is a box-shaped spore case, which bursts in the summer to liberate many spores. These spores are borne on the wind; if they land in moist and shady conditions they produce a small structure, the prothallus, which develops underground. This is where the sexual stage of reproduction takes place.

Fertilisation occurs when male sperm swim across the water film on the prothallus,

Above: Fir clubmoss (*Huperzia selago*) grows in damp mountainous areas of Scotland, northern England, Wales and Ireland. The spores, which are ripe from June to August, form a very fine yellow powder. Reproduction takes place asexually, when small buds formed on the leaves fall off and grow into new plants.

Opposite: Alpine clubmoss (*Diphasiastrum alpinum*) has square branched stems that creep along the ground, anchored by strong wiry roots. Clumps of erect branches are produced at intervals, with yellow cones containing the spore cases developing at the tips of some of them. The yellow spores are produced from June to August.

entering the neck of the female organ and fertilising the egg. The embryo thus formed starts dividing and growing into a new plant, absorbing nourishment from the prothallus until the new leaves are able to photosynthesise.

Looking at clubmosses Fir clubmoss is an upright, bushy plant, looking very like a small fir tree with its long, narrow, dark green leaves. The spore capsules in this species do not accumulate in cones, but are borne in the angle between a leaf and the stem. The plant is characteristic of high moorland areas, growing in crevices on wet rocks and heath.

Alpine clubmoss prefers mountainous areas, above 610m (2000ft). It is a more straggling plant than fir clubmoss with shorter, wider leaves which grow close to the stems in four definite ranks. The spore capsules form a cone shape, which is borne singly on a special fertile branch.

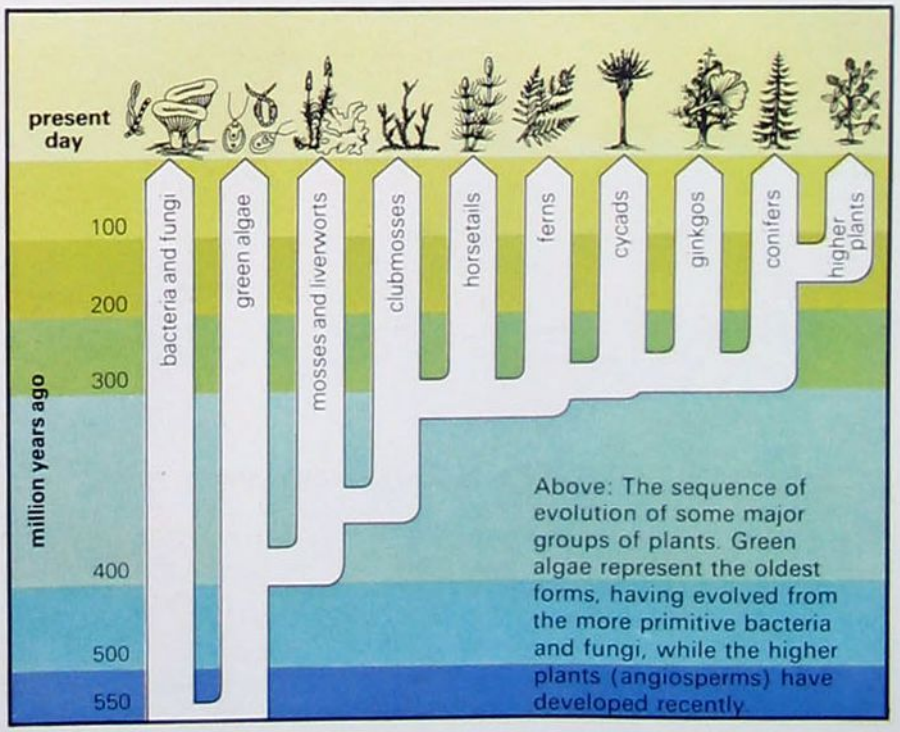
Stag's horn clubmoss is most noticeable when its cones appear. These are usually borne in pairs at the end of a long upright stem covered with small scale-like leaves. The stems are long and creeping with spirally arranged leaves. Once very common, stag's horn clubmoss is now no longer so widely seen, due to the loss of many of its favoured wet lowland habitats.

Interrupted clubmoss is also to be found in mountainous areas, as well as on moorland. It is a semi-upright plant with stiff bristly leaves growing around a stem that appears constricted or interrupted at intervals. The cones, which are borne singly, are made up of leaves that are different in shape and colour from those of the main stem.

Lesser clubmoss, found on wet rocks in mountainous areas of the British Isles, differs from the other species mentioned so far in having two kinds of spores – microspores and megaspores – borne in separate spore cases.

Above: Stag's horn clubmoss (*Lycopodium clavatum*), shown with paired cones, takes its name from its resemblance to the branched antlers of deer. The stems creep along the ground, rooting at intervals, and are thickly covered with leaves which have long hair-like tips. The kidney shaped spore cases growing in cones produce a bright yellow powder, lycopodium powder. This formerly had uses ranging from coating pills to making fireworks.

Right: The creeping stems of lesser clubmoss (*Selaginella selaginoides*) produce numerous upright branches with narrow pointed leaves. Large yellow-green megaspores appear in the lower parts of the large-leaved cones at the top of the plant.



Above: The sequence of evolution of some major groups of plants. Green algae represent the oldest forms, having evolved from the more primitive bacteria and fungi, while the higher plants (angiosperms) have developed recently.

SMALL, SECRETIVE SHREWS

The smallest mammal found in the British Isles is the pygmy shrew which is half the size of its relative, the common shrew. Both species are found in Great Britain, but the pygmy shrew also occurs in Ireland where it is called the 'dolly-mouse'.

Although called 'shrew-mice' in the country, the pygmy shrew and the common shrew are not rodents like mice and rats, but insectivores, a group that also contains the hedgehog and the mole. Both species are quite common although they are seldom seen as they stay well hidden in the undergrowth.

Both common and pygmy shrews favour habitats with long vegetation where they can hunt at ground level and not be seen by predators such as owls. Rough grassland, hedgerows and nettlebeds are favoured places. Shrews are especially common in young forestry plantations. In summer a Welsh plantation can have over 14 per acre, which is about twice the number that live in rough grassland. In most parts of mainland Britain, common shrews are five to ten times as abundant as pygmy shrews.

Common shrews make shallow runways in leaf litter and ground vegetation and tunnels through soil that are small in size and flat in cross-section. The pygmy shrew can also dig and burrow with its nose and front paws, but because of its tiny size it can also use holes and tunnels made by other animals such as beetles.

Carnivorous insectivores Shrews are called insectivores but they also eat other small animals, such as spiders and woodlice, as well as insects. Almost any living creature that is small enough is food for a shrew. Shrews hunt by bustling about at ground level, through their runways and down their shallow burrows, sticking their long snouts with sensitive whiskers into every crevice. They are constantly active and inquisitive. When the shrew finds a small creature, it gives the prey a quick sniff, grabs it in its jaws and crunches it up. Common shrews eat quite large snails and earthworms, which are too big for pygmy shrews. Both species eat woodlice, spiders and beetles.

Dr Pernetta, a researcher at Oxford University, found that pygmy shrews are not very fussy about their food – except that they never eat millipedes. Other small invertebrates were eaten in proportion to how many occurred at ground level. Common shrews also dislike millipedes, but spend more time hunting below ground level where they find worms and soil-dwelling insect grubs and larvae.

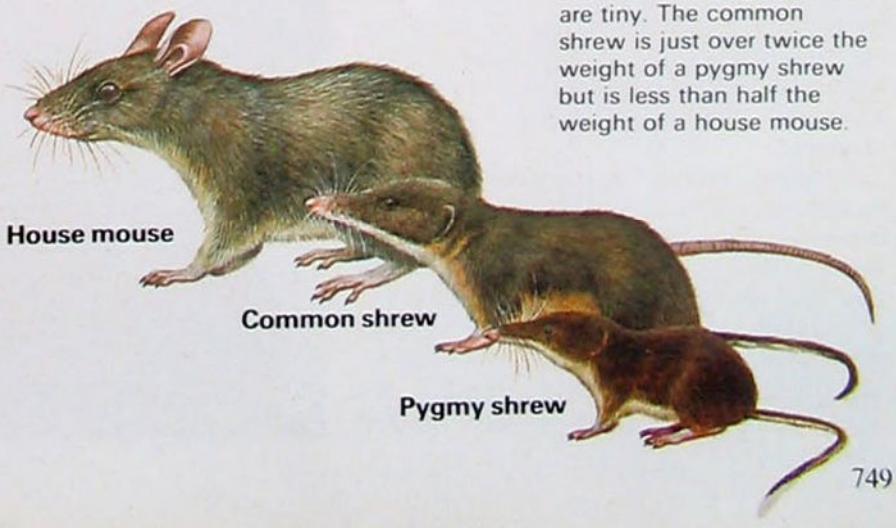
Food – a time-consuming affair A shrew needs large amounts of food at short, regular intervals. With such a tiny body, the surface area is large in proportion to its weight, and heat is easily lost. So the shrew must eat lots of food to convert into energy sufficient to keep its body temperature at about 37 C (98.4 F). In order to achieve this the shrew must eat every two or three hours or it dies. A typical day for a shrew consists of ten shifts, each about $1\frac{3}{4}$ hours in length, hunting for food. Between each burst of feeding activity there is a rest of about 45 minutes. It is a round-the-clock cycle, although the greatest active feeding behaviour takes place during the night.

Above: Nose to the ground. The pygmy shrew, like all shrews, has a long sensitive snout with fine whiskers. It uses its nose to find food that includes not only insects but any animal that is small enough to eat, such as beetles, woodlice and spiders.

Each day a common shrew eats almost its own weight in food, and a female suckling her young needs one and a half times her own weight. Pygmy shrews require even more food – they lose more heat because their surface area to volume ratio is greater and so they need to eat over twice their own weight in a day to keep active.

Life and death In autumn shrews grow a thick coat to help them survive the winter. However, the winter months are a difficult time for shrews since insects are inactive and other invertebrates are difficult to find. As a result many shrews die as they are unable

Shrew and mouse line-up



Compared with mice, both common and pygmy shrews are tiny. The common shrew is just over twice the weight of a pygmy shrew but is less than half the weight of a house mouse.

to find enough food. A common sight from late summer to early spring is a shrew lying dead in the open on a footpath or road due to starvation.

The survivors moult to their summer coats in April and May at the start of the breeding season. Females have litters of five to seven young and can have up to five litters in a season. By August the old shrews have endured a year of furious activity, finding food, breeding and avoiding predators. If a shrew manages to live to 15 months (a good age for a shrew) it dies of old age.

Battling midgets Shrews are most aggressive, anti-social animals. Without exception they hate their neighbours. Within eight weeks of its birth each shrew has carved out its own territory, from which it excludes all others of its own species. If two shrews meet they have a squeaking and scuffling battle. The nearer a shrew is to its home the harder it fights to establish and maintain territorial boundaries. Although these fights sound fierce, they are rituals and the shrews almost never wound each other. As with most fights over territory, the shrew that is defending its own ground is more likely to be the winner than the shrew that has ventured into anothers property.

Females allow their own young to stay in their territories until after they are weaned but they do not share their territory with their mates. Within a day after giving birth to her babies, the female is receptive to males, allowing one to approach her territory. The male shrew holds her by the scruff of the neck while he mates with her. After mating, male and female separate and return to aggressive defence of their individual territories.

Avoidance tactics Since pygmy and common shrews eat different sizes of prey and the common shrew spends more time hunting below ground than does the pygmy, it seems that the two species are not in fierce competition with each other. Outside the breeding season each shrew chases all others of its own species from its territory, but the territories of pygmy and common shrews often overlap. This does not mean that the two species are tolerant of each other. A pygmy shrew is careful to avoid the common shrews in its territory. It dashes off before the common shrew has had a chance to notice it.

Dr Peter Crowcroft, one of the first scientists to make a detailed study of British shrews, has explained the relationship between the species in delightful prose. He imagined that he was interviewing each shrew for its opinion on the other. Pygmy shrews thought common shrews 'stupid lumbering brutes, always in the way'. Common shrews said 'Pygmy shrews? You don't really believe in them do you?'

Obviously pygmy shrews would have an

COMMON SHREW
(*Sorex araneus*)
Size Head and body 6–8cm (2½–3in), tail 3–4cm (1⅛–1½in), weight 7–10g (¼–⅜oz).
Colour Grey-brown top, red-brown flanks, white-grey underside.
Breeding season April to August.
Gestation 24 days.
Number of young 5–7.
Food Worms, insects, spiders, snails, woodlice.
Lifespan 12–15 months.
Predators Owls.

PYGMY SHREW
(*Sorex minutus*)
Size Head and body 4–6cm (1½–3in), tail 3–4cm (1⅛–1½in), weight 3–4g (about ⅛oz).
Colour Grey-brown back and flanks, white-grey underside.
Breeding season April to August.
Gestation 22 days.
Number of young 4–7.
Food Insects, spiders.
Lifespan 12–15 months.

Caravanning capers

The young of certain species of shrews, including the European white-toothed shrews, hold on to their mother and each other in early explorations. A recent report in Scotland says common shrews caravan, too.

Below: A common shrew eating an earthworm. Each day this species needs to eat its own weight in food in order to survive.

easier life if there were no common shrews to get in the way–and this seems to be the case in Ireland. In a small scale study in south-west Ireland, where the common shrew does not occur the author found that pygmy shrews are as common as the combined numbers of common and pygmy shrews in Essex. This suggests that the two species are competitors.

Parasites Both common and pygmy shrews suffer from fleas. Some flea species live only on shrews, but the large mole flea and several rodent fleas will take blood from them if their usual host is not around.

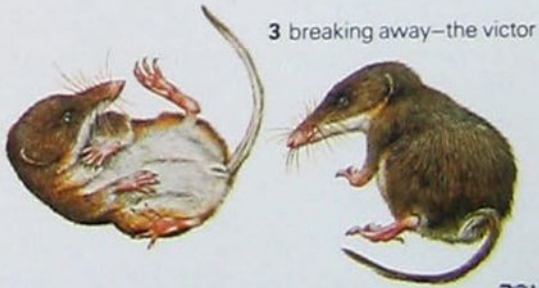
A bad reputation The aggressive nature of shrews is the reason why sharp-tongued women are called shrews, or are said to have a shrewish nature. Until quite recently shrews were supposed to have an extremely poisonous bite–and they did not even need to bite to cause death. According to Topsell's *History of Four-footed Beasts* (1607) 'If horses or any other labouring creature do feed in that pasture or grass in which a shrew shall put forth her venom or poison in, they will presently die'. The supposed remedy for horses and cattle made ill by shrews was to entomb a living shrew in a hole in an ash tree. When the shrew died it caused the ash to become a 'shrew-ash' whose branches supposedly made the perfect cure.

The danger of shrews to man and his animals is fiction and not fact. Shrews are harmless to large animals but certain species of shrew (including the water shrew) have poison in their saliva that helps to paralyse prey. Common and pygmy shrews do not seem to be able to do this, but they do have skin glands on their flanks that produce a smelly secretion. It is probable that this bad smell gave rise to the folk-lore about the dangers of shrews. Male shrews have larger stink glands than females and the smell probably helps the sexes to find each other. It may also help protect the shrews from predators. Owls eat large numbers of shrews but many mammals (with a more sensitive sense of smell than birds) refuse to eat them. Domestic cats often kill shrews but hardly ever eat them.

Above: Common shrew licking its everted rectum. It is thought that this allows bacteria–vital to the breakdown of the food eaten by the shrew–to re-enter the digestive cycle.

Right: Nest of baby common shrews. Although they are born naked and blind, their hair soon begins to grow and their eyes open on about the 18th day. Small mites, visible on the skin of two of the babies, usually live in the leaf litters, attaching themselves to the host only when feeding.

Outside the breeding season, when two shrews of the same species meet, there is a furious fight between them (left and below). Although shrieks and tumbles occur, wounds are rare.



Pantotheres–shrew-like mammal ancestors

In the middle Jurassic (160 million years ago), when dinosaurs still roamed the earth, and were to exist for another 100 million years before they became extinct, small insect-eating mammals called Pantotheres lived in the British Isles. They appear to have been widespread in many parts of the world, but the first fossils were found in slate quarries at Stonesfield in Oxfordshire. The fossils consist only of teeth and a few bits of skeleton, but by careful study, scientists can make a reasonable construction at what a Pantothere looked like. A Pantothere was very shrew-like in features but was twice as long as a modern shrew.

Almost certainly the Pantotheres are the ancestors of all the true placental animals. Apart from getting even smaller and evolving different teeth and bone structures, modern shrews have not changed much in 160 million years. In the same time-span other Pantotheres evolved into other mammals such as lions, horses, whales and man.

MAIDENHAIR: IN A CLASS OF ITS OWN

The maidenhair tree, or ginkgo as it is often known, the sole survivor of an ancient group of plants, is found growing wild only in remote parts of China. During the past 200 years it has been planted here for its graceful shape and distinctive foliage.

Right: **Maidenhair** or **ginkgo** (*Ginkgo biloba*). Introduced, deciduous, grows to 30m (100ft). Planted in botanical gardens, city parks and gardens. Flowers spring, rarely fruits in the British Isles.

Opposite: The famous ginkgo in Kew Gardens which was planted there in 1754. Like most ginkgos in the British Isles, it is a male tree. Both male and female specimens grow in the Chelsea Physic Garden in London.

Below: In autumn the distinctive foliage of the ginkgo turns a beautiful golden yellow colour.

The maidenhair tree, or ginkgo, is one of the most ancient surviving trees. Imprints of the characteristic fan-shaped leaves have been found in fossils dating back over 190 million years. Then the ginkgo enjoyed a world-wide distribution, but later its place was taken by more 'modern' trees – the enormously successful conifers and flowering trees that came to dominate the world's forests. Over millions of years its range contracted and now the species has become relegated to a few scattered mountain forests in China.

In some ways the ginkgo could not have been in a worse place for its 'last stand', because for centuries the pressure on China's forests has been so intense that only fragments of the natural tree cover remain. The rest of the forest has been cleared to make way for agriculture and to provide firewood and timber.

Today the ginkgo is all but extinct in the wild, but fortunately over the centuries it was widely planted in temple gardens throughout China and Japan where it was kept as a sacred tree. Those gardens supplied the first specimens to Europe in about 1730. Kew Gardens obtained their first specimen in 1754, and it still grows there.

Unique tree When botanists first studied the ginkgo they were puzzled as to how it should be classified. At first they thought it must be some sort of primitive conifer and it was put into the Yew family. Later they realised it was indeed a unique tree and deserved a class of its own – the Ginkgoales – of which *Ginkgo biloba* is the sole surviving representative.

The Japanese nick-named it the duck's foot tree, because the leaf shape is rather like a webbed foot. The French called it the '40 sovereign tree', from the price they paid for one of the first specimens to be planted in France. The common name we use – maidenhair – indicates the close resemblance between the shape of its foliage and the fronds of the delicate maidenhair fern (page 265).

Graceful appearance The ginkgo is a deciduous tree which grows to about 30m (100ft) tall, forming a crown which is generally triangular in outline. In the early stages of growth the tree can be angular and rather ungainly, especially in exposed sites. The trunk often forks quite close to the ground, sending up two or more main stems which carry the spreading side branches. These divide further into the leaf-bearing shoots that tend to droop, and with age the tree acquires a distinctly graceful appearance. In old trees the trunk is often fluted, and the brown cork-like bark develops deep fissures and rugged longitudinal ridges.

The distinctive pale green leaves are borne on slender stalks 4-9cm ($1\frac{1}{2}$-$3\frac{1}{2}$in) long. The

Above: The gingko's young bright green leaves resemble the maidenhair fern—hence the tree's other name, maidenhair.

Below: The bole of a ginkgo forks close to the ground, making the tree easy to identify in winter when the leaves have fallen.

fan-shaped leaf blade is marked by a central notch at the broad end (hence the Latin species name, *biloba*, which means two-lobed). The veins fan out from the base, sometimes forking before reaching the slightly wavy leaf margin. Before falling in autumn, they turn a beautiful rich yellow—the colour spreading slowly from the broad edge towards the leaf stalk.

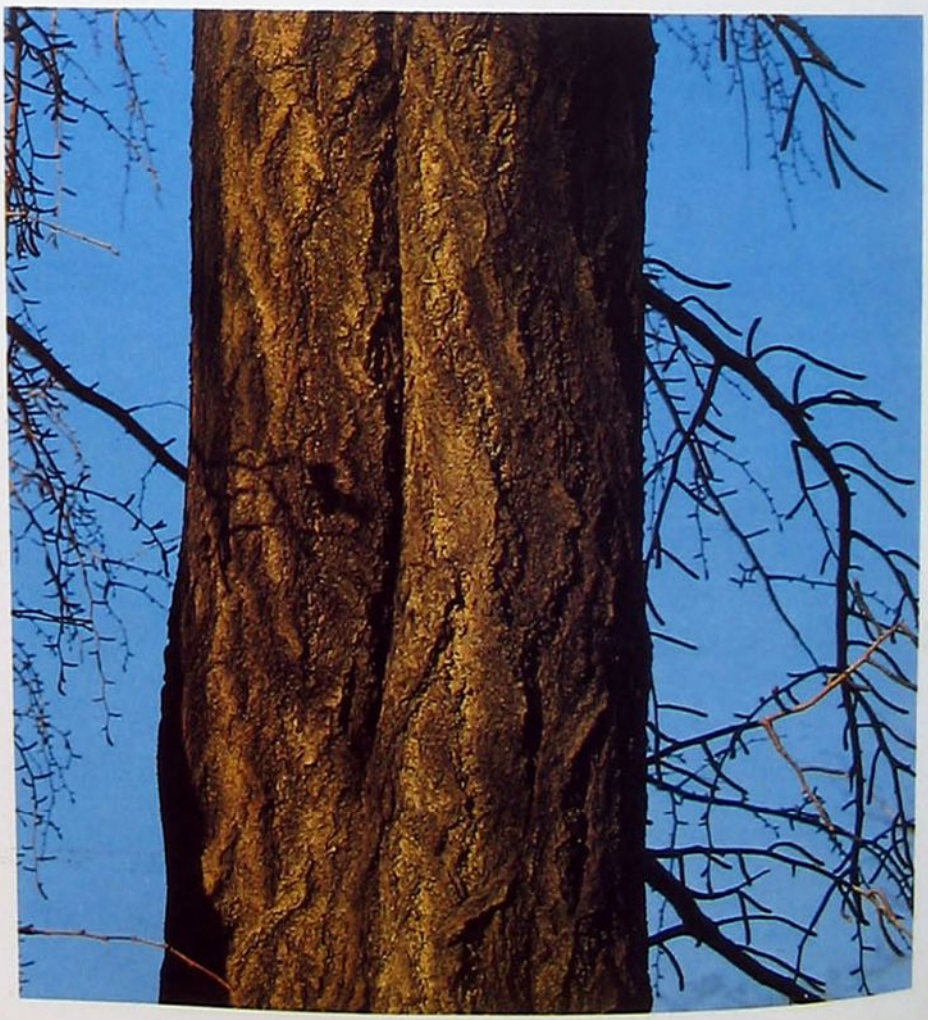
Like some conifers, such as pines or cedars, the ginkgo is unusual in having two different kinds of shoot. Some are slow-growing and remain short and bear leaves in clusters at their tips. Others are much longer, faster growing shoots, with leaves placed alternately along their length.

The ginkgo flowers in spring as the new season's foliage is unfolding. The trees are either male or female, and the flowering structures sprout from little woody short shoots, each about 3cm (1¼in) long. The male flowers are simply a bunch of greenish pollen-bearing stamens; the female flowers consist of a slender stalk about 4cm (1½in) long, tipped with two tiny green ovules. The ovules are exposed and naked, which means that they can be fertilised on direct contact with wind-blown pollen.

After fertilisation a yellow-green fruit, resembling a little plum, is formed. The flesh of the fruit has a horrendous rotting smell, but the woody stone it surrounds has an edible kernel prized by the Japanese.

It is rare for the trees in Europe to produce fruit because they are usually planted as isolated ornamentals in parks and gardens and along city streets, too widely separated from each other for the successful transfer of pollen. And curiously, in any case, most of the trees that have reached flowering age in the British Isles have proved to be males.

The ginkgo has a pale creamy yellow wood which has a fragrant smell and was much used in China for making coffins.



WATER BUGS: COMING UP FOR AIR

Water bugs such as saucer bugs and water boatmen, being insects, must all breathe air. The ways they have of doing this under the water surface are diverse and fascinating.

Bugs are distinguished by having mouthparts in the form of a piercing and sucking beak through which they can take only liquid food, such as the sap of plants or the body fluids of animals. They are found in great variety on the land, but a much smaller number of species inhabit fresh water. Some of the truly aquatic underwater bugs are predators, while others feed on algae and particles of organic matter and, with one exception, they are adapted to breathe atmospheric air and must visit the surface to obtain it.

Backswimmers The most familiar water bugs are the backswimmers, sometimes also called water boatmen. You can see them on almost any fairly clean weedy pond or ditch, floating just under the surface or swimming down as you approach. If you come close to the water and keep quite still, they soon reappear and float again, with tails just projecting through the surface film.

Both when floating and when swimming these insects look remarkably like tiny boats propelled by a single pair of oars. These 'oars' are the hindmost pair of legs, and are long and fringed with hair – two adaptations that make swimming easier. The two front pairs of legs are short and form a cluster just behind the head. They appear to be on top of the body, but this is an illusion produced by the fact that the insect always floats and swims upside down. An unusual discovery has been made about this upside down swimming. It seems to be controlled by the insect's sense of sight rather than by any appreciation of gravity. If a backswimmer is put into a glass tank lit from below, it swims with the back uppermost.

There are several species of backswimmer, the most common one being *Notonecta glauca*, which is about 15mm (½in) long. These insects are fierce predators, taking insects, tadpoles and even little fish under the water and also drowning flies at the surface. They kill their prey by holding it with the four front legs and piercing it with their sharp beaks. A combined poison and digestive fluid is injected and the contents of the prey are liquefied and sucked back. If you catch a backswimmer, be very careful in handling it; a jab from the beak is extremely painful.

Backswimmers take in air at the surface through their hind ends. When the insect dives it carries with it an air supply in a bubble held mainly by the hairs along the ventral (underside) surface of the body, but also between the wings and the body. The bubble is in contact with the spiracles (breathing tubes) on the thorax. The air makes the insect buoyant when it is submerged and it has to swim vigorously when diving, and cling to some underwater object in order to stay down. The backswimmer's eggs are laid in the spring, embedded in the stems of plants, and the nymphs take about two months to reach adulthood.

Above: A pair of corixas, or water boatmen. The forelegs of the male are used for producing a high-pitched courtship song, made by stroking the legs against the margin of the head. The insects that sing, or stridulate, often have sound-producing apparatus that, examined with a microscope, gives a reliable means of identifying the species. The males of the numerous kinds of corixas have rows of tiny pegs on the forelegs, the number and disposition of which differs very consistently in the different species. The male of each species sings a particular 'signature tune' which is recognised by females of his own kind.

Corixid water boatmen If you fish about in water weeds with a dip net you can often find smaller insects that look like backswimmers and swim in the same way, by rowing with the hindmost legs. They differ from *Notonecta* in being flatter, with a more rounded outline, and in swimming the right way up, that is with the dorsal (top) side upwards. There are quite a number of species, but the largest and one of the commonest is the common corixa (*Corixa punctata*), which is about 12mm ($\frac{1}{2}$in) long.

The corixas are not closely related to the backswimmers and are not predators, but feed by sieving the water through hairs on the front legs and straining out fine organic particles and algae, which are then sucked in by the short beak. The main air supply is carried as a bubble between the back and the wings and is captured at the surface by the head and thorax (and not via the tail end as in *Notonecta*). Corixas lay eggs from January to March, fixing them to the leaves and stems of aquatic plants.

Above: A backswimmer (*Notonecta*) swims upside down. It has well-developed wings and flies freely.

Below: Water stick insect (*Ranatra linearis*) – it is about 6–7cm ($2\frac{1}{2}$in) long.

The hind legs of both types of water boatman are beautifully adapted for rowing. On the propulsive back stroke the hairs that fringe the legs towards their tips spread out and resist the water, but fold up and offer no effective resistance on the recovery stroke.

The saucer bug is found only in the southern half of Britain, but within its range it is often common in muddy and weedy ponds and ditches, living on the bottom and surfacing to breathe at fairly long intervals. Its air supply is carried between wings and body. It is 12-16mm ($\frac{1}{2}$in) long, broad-bodied and flat and rather beetle-like in appearance. A curious feature is that it has well-developed wings, but muscles so reduced that it cannot fly. The bugs probably colonize new water by creeping over the land; the legs are less modified for swimming than those of corixas and backswimmers. The saucer bug is a fierce predator and kills its prey just as backswimmers do; its bite is also equally painful.

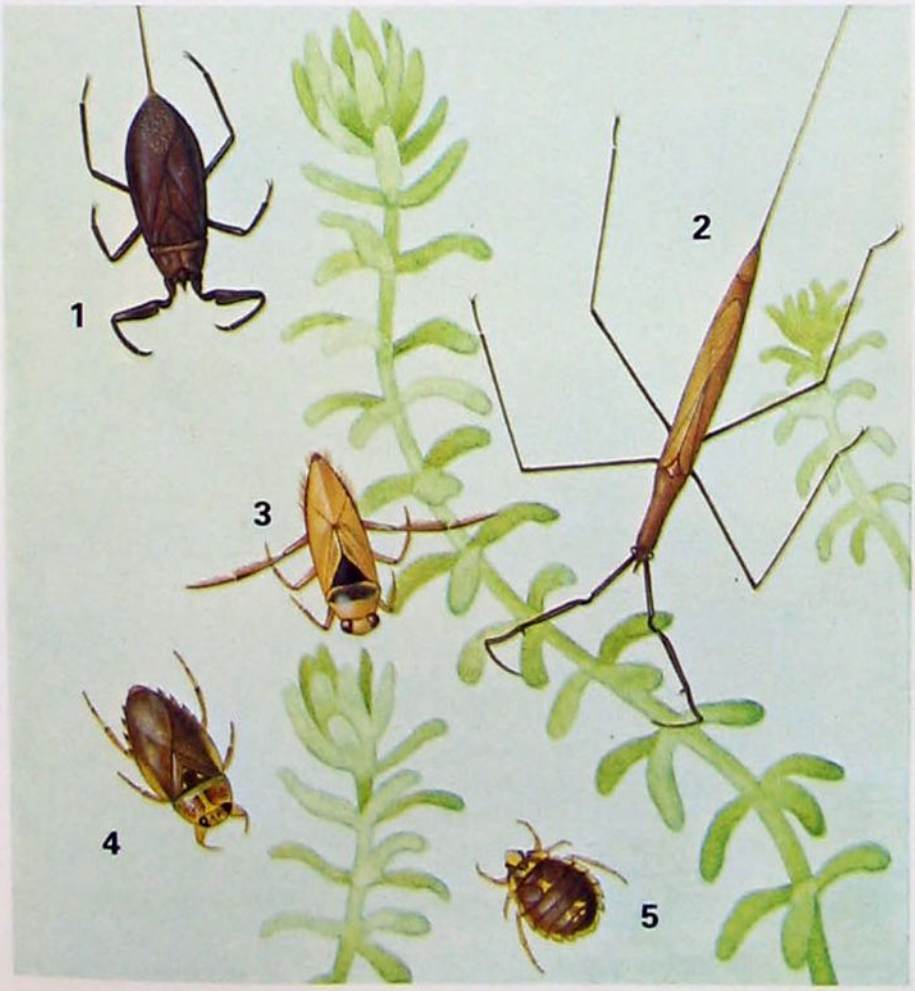
Another broad-bodied predatory bug is the uncommon and seldom-seen *Aphelocheirus aestivalis*. Its distribution is based on old-established river systems, including the Thames and the Severn. The most interesting feature of this insect is its remarkable respiratory system. The body is largely covered by microscopic hairs, so minute as to number two million to the square millimetre. This hair covering is unwettable, and carries a film of air into which oxygen continually diffuses from the water. This so-called 'plastron' is developed only in the adult bug; in the nymph respiration takes place through the skin. It is also present in some kinds of water beetle, and is really a type of gill since it extracts oxygen from water.

Water scorpions There are two British bugs belong to the Nepidae, or water scorpion, family. Their chief peculiarity is their breathing apparatus, which has the form of a tube or 'snorkel' at the tip of the tail. It looks like a sting, and may alarm people unfamiliar with the creature's habits. Of the two species, *Nepa cinerea* is the more common, living in shallow weedy ponds.

The water scorpion's movements are slug-

Right: Water scorpion (*Nepa cinerea*) resting on reeds underwater. It is a dark brown flattened insect, about 19mm ($\frac{3}{4}$in) long, with a 'tail' over half as long again. The whole insect looks very much like a decayed leaf. The forelegs are sharply angled and used for grasping prey, and they do have a rather remote resemblance to the claws of a scorpion. The victim is despatched and its body contents extracted by the poison-injecting and sucking beak.

Below: The underwater-dwelling water bugs have various different methods of breathing. (Note that you would not find all these different bugs in the same stretch of water.)
1 Water scorpion *(Nepa cinerea).*
2 Water stick insect *(Ranatra linearis).*
3 Backswimmer, or water boatman *(Notonecta glauca).*
4 Saucer bug *(Ilyocoris cimicoides).*
5 Water bug *(Aphelocheirus aestivalis).*



gish and mainly confined to walking on the bottom of the pond, although it can swim rather awkwardly to reach the surface and extrude the tip of its breathing tube; normally it does this by climbing up water plants.

If you lift the wing cases (really the fore-wings) you can see the brightly coloured pink and red hind wings. There is some uncertainty about the water scorpion's ability to fly. In most specimens the wing muscles are so weakly developed that flight is impossible, but some individuals have been seen to fly so this must be a variable feature.

The water stick insect is considerably larger than the water scorpion; its English name describes it very well. The forelegs are adapted for seizing prey, like those of the water scorpion, but are longer and more slender. The breathing tube is only a little shorter than the body. Water stick insects can fly well and use this means of escape from pools that threaten to dry up. The species is restricted to the southern half of Britain, and frequents fairly deep pools with water plants growing around their margins.

The eggs are laid in rows in the stems of water plants, and each egg has two thread-like appendages at one end. The nymphs have a fairly short tail and when they are small they hang down from the surface film of the water by their legs, with the breathing tube just breaking the film. Adults can remain below for 30 minutes or so.

A WINTER'S DAY IN THE OAKWOODS

Winter is sometimes called the dead season. But as you go through the silent woods in January do not be deceived into thinking that nothing is alive. Winter is a resting season, when life's chemical processes, although slowed down, still go on.

Think of the common woodland wild flowers. If such plants can be said to have a dead season, it is summer, rather than winter, when certain species show the least life. When lesser celandines and wood anemones have finished blooming in spring they quickly vanish – flowers, leaves and stems all rot away. And the carpets of bluebells, so colourful, lush and sappy in May, have quite disappeared by August. Yet these plants, and others, are all actively growing again, above or below ground, by the end of the year; and already in January, if the season is mild enough, celandines, anemones and primroses may be showing their first flowers.

Not all our winters are mild, and plants

and animals have to be able to take this fact into account. As they evolved over millions of years one of their continual and pressing requirements has been to develop a method of getting safely through the coldest winter. A common solution to this problem is to take refuge in the winter woods. To see why, you need only take a walk some bitter winter's day, when you have to struggle against an icy north-east gale along a frozen field path that leads you to a wood, especially one with plenty of undergrowth. Once you're among the trees you are in a different world – less cold, sheltered and altogether more habitable. A woodland has a climate of its own; and the bigger the wood the more sheltered are its depths where tender species can escape the worst frosts and drying winds.

Leaf mould To tell the complete story of oakwoods in winter it is necessary to begin in the autumn, when the leaves are falling, for they play a large part in the life of the wood at all seasons. They lie thick on the ground for a few weeks, but in the dampness of early winter they are attacked by moulds and fungi and gradually decay, adding their substance to the leafmould.

So the woodland soil is formed, not only of leaves but also of twigs, branches and fallen trunks, along with all the dead plants, dead animals and animal droppings that eventually fall to the ground. This soil and its leafmould cover become a deep and fertile layer, providing food and a habitat for countless forms of life, especially in winter.

As well as leaves there are acorns to help form the woodland soil. In some years they are produced in such multitudes that several hundred may lie in a single square yard below an oak. Then what happens? Few of them are left to lie. They are quickly found and either eaten or hidden by woodpigeons, jays, rooks, pheasants, deer, squirrels, mice, voles and insects. Most of the rest are attacked by fungi. The result is that only a very few of these millions of acorns ever germinate.

Evergreen plants Some midwinter wild flowers which disappear in summer, but not all woodland plants are so ephemeral. There is wood-sorrel, for example, whose ground-covering carpets of clover-like leaves are green the whole year round and often climb decoratively over stumps and fallen trunks. Then there are mosses and liverworts. Because they flourish in cool dampness, winter is their best season; they can be enormously abundant, covering ground, tree trunks and high branches in an ever fresh, bright-green mantle. Hardy against frosts, many of them choose winter as the time to produce their fruits, which often stand up elegantly on slender stalks.

Many ferns, too, are evergreen and remain standing in the shelter of the winter woods; and those that die down, bracken for example, provide a thick warm shelter for numerous small animals. On tree trunks, branches and twigs many kinds of lichens occur, some bushy, some leafy and some formed into flat crusts. All are hardy and are not troubled in the least by winter's cold.

Hidden hordes Perhaps you have examined leaf mould in summer and found it crawling with invertebrates – all the myriads of mites, millipedes, centipedes, earthworms, beetles and other creatures. They are all there in January, too, some hibernating, some simply hiding, ready to creep out and seek food during mild spells.

Similar communities live up in the trees – woodlice, false scorpions, spiders and many others which exploit the warm damp micro-

Above: The brambling comes to the oakwoods in winter, joining the resident tits, nuthatches, tree creepers, woodpeckers, wood pigeons, crows, jays, robins and wrens. In contrast to the summer visitors, these birds know where to find the food that is available in winter, behind bark and among leaves.

Right: A wood cricket, one member of the large community of ground-dwelling invertebrates, ventures forth.

Above: Hoar frost on a clutch of oak marble galls. Each one is the winter home of a larva which eventually emerges as a female gall wasp 3mm ($\frac{1}{8}$in) long – provided it has not been seized by a woodpecker or consumed by insect parasites. A smaller hole found in a marble gall may be where the wasp has already emerged; a larger one is more likely to be caused by the beak of some foraging bird.

climates to be found behind the sheets of loose bark or in decaying holes. There are also legions of beetle larvae burrowing away all winter into the wood of trees. Some moth larvae are found, too, like those of the clear-wings; or the big, red-brown caterpillars of the goat moth, which bore large holes into oaks and other trees.

Oakwood moths Go into the wood some mild winter night, preferably in the week or two before Christmas, and you'll find moths in plenty: these are winter moths and mottled umbers. They flutter round your torch, or you can see them crawling up the trunks of the oaks. The ones you see flying are all males which have just emerged from their pupae in the earth, and their one aim is to find a female with whom to mate. The female's story is just as simply told: she appears from the ground and crawls up an oak–lacking wings, she cannot fly. During her ascent she mates with one of the waiting males, then goes on climbing to some high twig, where she lays her eggs near the tightly closed leaf buds.

The scores of other oakwood moths, as well as the various butterflies, have each in their fashion evolved a way of coping with the cold and hunger of winter. Most have opted for dormancy, either as eggs or pupae. But in October or November the brimstone butterfly hides away among ivy or other green cover in adult form, and is ready to fly again before winter is over if a sufficiently warm day occurs. The footman moths, on the other hand, pass the winter as active caterpillars, eating leafy lichens on the oaks during spells of milder weather.

Hibernators Only a few vertebrate animals have chosen hibernation as their means of survival. Toads, grass snakes and adders come into the woods in fair numbers to

A drey or nest (above) and its occupant, a grey squirrel (right). Some British mammals do not hibernate, although they are less active in winter than summer. In cold spells, grey and red squirrels pass a large part of the day in the nest, while badgers lie up for several days and nights in a row. Foxes are noisily active on December and January nights, barking and screaming as they sort out which males have priority in the choice of female partners.

Below: Bracket fungi are easiest to find in winter. They are leathery or even wood-like and are unaffected by the severest weather. This one, known as *Coriolus versicolor,* grows on fallen hardwood including oak.

get out of the cold, squeezing into holes in the ground. Hedgehogs make elaborate weatherproof nests of dry leaves, grasses, mosses and bracken in a sheltered spot and are snug the winter through. Dormice also sleep the cold weather away in mossy nests.

Travellers and residents Hibernation is an escape route the birds do not take. Instead, many of them migrate: warblers, redstarts and flycatchers depart south in the later weeks of summer. Soon afterwards come the first arrivals from cold northern Europe: woodcock, redwings, fieldfares and some of the finches from the Arctic.

Some of the woodland birds (residents or visitors) are solitary species–woodpigeon, jay and woodcock for example. Others move around the woods all day in parties of mixed species. Such a flock may afford a measure of safety in that a predator can be detected and warning given to the whole party, whereas a solitary bird must rely solely on its own watchfulness. As you follow a woodland path in winter the scene may seem silent and lifeless until you meet a bird party. Then you may see scores of tits, nuthatches, tree creepers and others fluttering about and calling frequently as they pass through the trees. They feed as they go, each species taking its chosen types of food and so not competing with the others. Then the whole flock moves on, leaving you again in the quiet of the woods.

IVY: TENACIOUS GREEN MANTLE

Ivy, so different in looks and life-style from all our other forms of vegetation, is an abundant woody climber found in most areas of Britain. During autumn and winter it stays beautifully green and offers food and shelter to all kinds of wildlife.

One of the most familiar and distinctive of our native plants, ivy stands alone as the only British member of the Araliaceae, a large family found mainly in the tropics. Our ivy is *Hedera helix*, the genus *Hedera* comprising 14 other species found mainly in the northern hemisphere. Ivy should not be confused with ground ivy (*Glechoma hederacea*), a common member of the thyme family, nor with the hated poison ivy (*Rhus radicans*), an abundant American species.

Ivy is hardy enough to flourish and remain green through the comparatively mild Atlantic winters of western Europe, but is absent from regions of a more continental-type climate in central and eastern

Europe. Its flowering shoots are sometimes killed by severe frosts.

Persistent climber Ivy is best known as a climber able to reach high up trees, cliffs or walls. It does not entwine itself round its support like honeysuckle or a runner bean plant. Instead it produces numerous, short, stump-like roots grouped along its brittle stem, which possess adhesive discs for holding firmly to bark or rough stone. Contrary to popular belief, ivy does not live parasitically on its host tree as, for example, does mistletoe. Mistletoe roots penetrate the tissues of the host tree, absorbing the juices. Ivy's feeding roots are usually in the ground, except occasionally when its bird-sown seeds germinate in crevices of rocks or walls. Though not itself a parasite, ivy is victimised by a parasite, the ivy broomrape, which grows on ivy roots. However, ivy can often swamp out a tree, and kill it by 'smothering'.

Two leaf-types Typical ivy leaves have either three or five well defined lobes. The leaves are leathery, hairless, glossy, dark green on top and paler beneath, with light green veins that make a beautiful surface pattern. When the leaves are growing against a vertical surface they arrange themselves with a minimum of overlapping to give each leaf maximum light. The leaf lobes vary greatly in shape: some are bluntly rounded, others long and narrow.

The stems that carry the lobed leaves are in a vegetative state. Ivy can live in dense shade, but to produce flowers it needs plenty of light; it does not become fertile until it has climbed to a sunny position high in a tree or on top of a wall. The leaves it produces then are quite different: instead of being lobed they are a simple egg-shape, except for their pointed ends. If you strike a cutting from a fertile branch it will grow into a fertile free-standing ivy bush, with simple leaves and without climbing roots. While the vegetative stems cling tightly to their support, the fertile branches, lacking climbing roots, spread out in a loose bush shape or hang vertically.

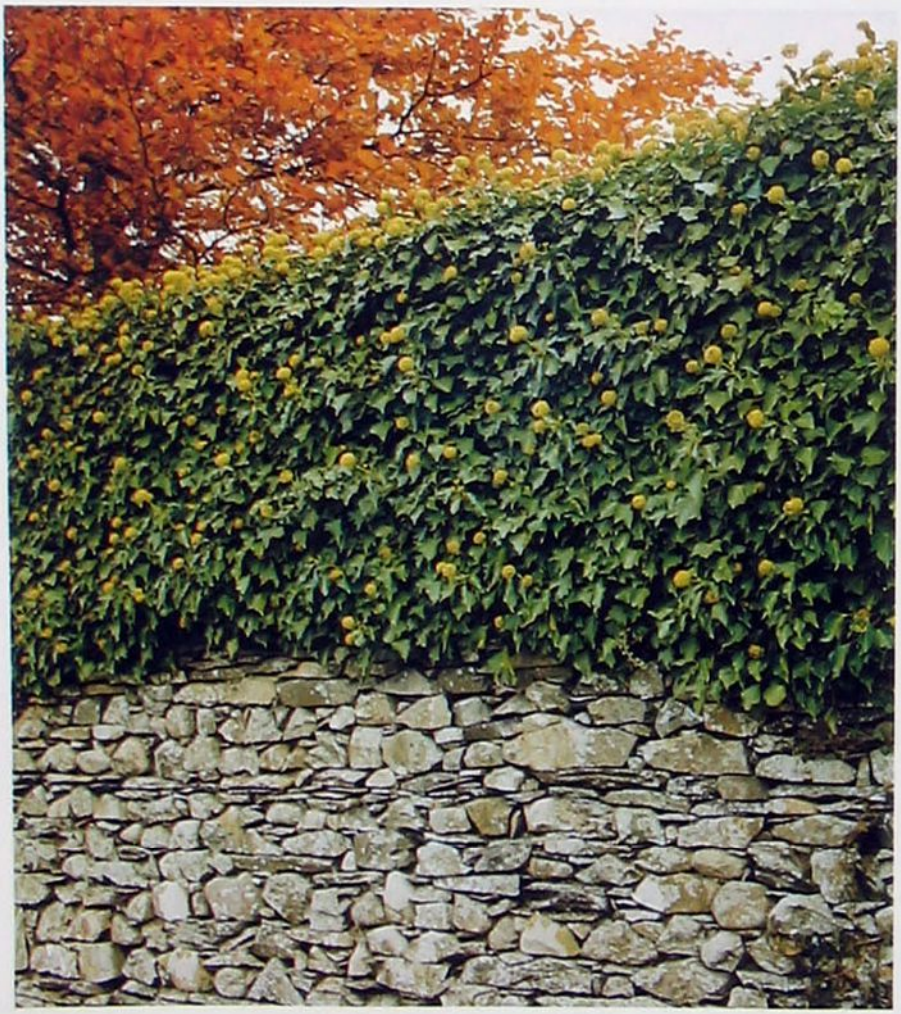
Prolific flowers and fruits The flower buds begin to be noticeable at the tips of the twigs from midsummer onwards. They are grey-green little knobs which grow slowly and do not begin to open into umbels of flowers until September. Other blooms follow until December. The yellow-green flowers have five sepals, petals, stamens and a five-celled ovary. Nectar is yielded freely to the many insects which come to this last feast of the year, attracted by a scent which is unpleasant to us. For many insects, such as worker wasps, it is the last food of their lives. For others, such as honey bees, it is a final chance to gather sustenance for winter. Besides numerous wasps, bees and flies, there are many moths eager for the ivy's nectar, and all help with pollination.

By the end of the year many clusters of small, hard, green berries have formed and during January and February they slowly swell and turn black. They are conspicuous against the green leaves so birds can easily find them. Huge numbers are taken by wood pigeons, blackbirds, mistle thrushes, robins and other residents. Winter redwings feed on them before going north with the spring.

Different types of ivy shoots

Ivy *(Hedera helix)*. Evergreen, grows to 33m (100ft) on most soils. Flowering shoot has simple egg-shaped leaves, vegetative shoot has lobed leaves. Flowers Sept onwards, fruits Dec.

Below: Ivy in flower on a stone wall. Many varieties of ivy have been developed by nurserymen who have selected unusual shapes and sizes, and different colours, for ground cover and clothing walls in parks and gardens.



Newly arrived blackcaps eat them in April. Most people tend to regard these berries as poisonous, but 'unpalatable' seems a better description. Indeed, the name ivy comes from an old Germanic word, *ifig*, meaning bitter, from the taste of the fruits.

Green floor cover A great deal of ivy never finds anything to climb up. Instead it carpets the ground, and can be a rapid colonizer of the floor of recently felled woodland. It is sometimes abundant in beech-woods where it meets with less competition from other ground plants than in the lighter conditions of oakwoods and ashwoods. It spreads over the ground, sending out frail roots from the leaf axils. Such carpeting ivy can be useful in preventing erosion on steep banks. In gardens it is frequently planted as ground cover and strong plants such as narcissi, snowdrops, lily-of-the-valley and montbretia are planted among it.

Friend or foe? Because of its beautiful foliage ivy is often planted on the walls of houses where, provided it is carefully kept away from roofs and gutterings, some people believe it keeps a house warm and dry. But others say it causes damp walls because it keeps away the drying effect of wind. Ivy is never tolerated on the walls of well-managed ancient monuments on the grounds that its weight and roots threaten to tear down frail masonry. Another grievance some have against ivy on buildings is that it harbours roosting and nesting house sparrows.

The traditional forester's attitude has always been hostile. For him ivy is a pest in many ways: it is thought that the closely set leaves and stems clinging to a trunk prevent the tree from breathing healthily through its bark, so reducing the rate of growth; it is also thought that the ivy's feeding roots compete underground with those of its host. Certainly if a huge head of ivy develops in a tree top it can threaten the tree by smothering its leaves, or by weighing its branches down until they break, or by acting as a sail, thus increasing the risk of gale damage. Finally, when a thick ivied tree is felled much time is lost because the ivy has to be stripped off.

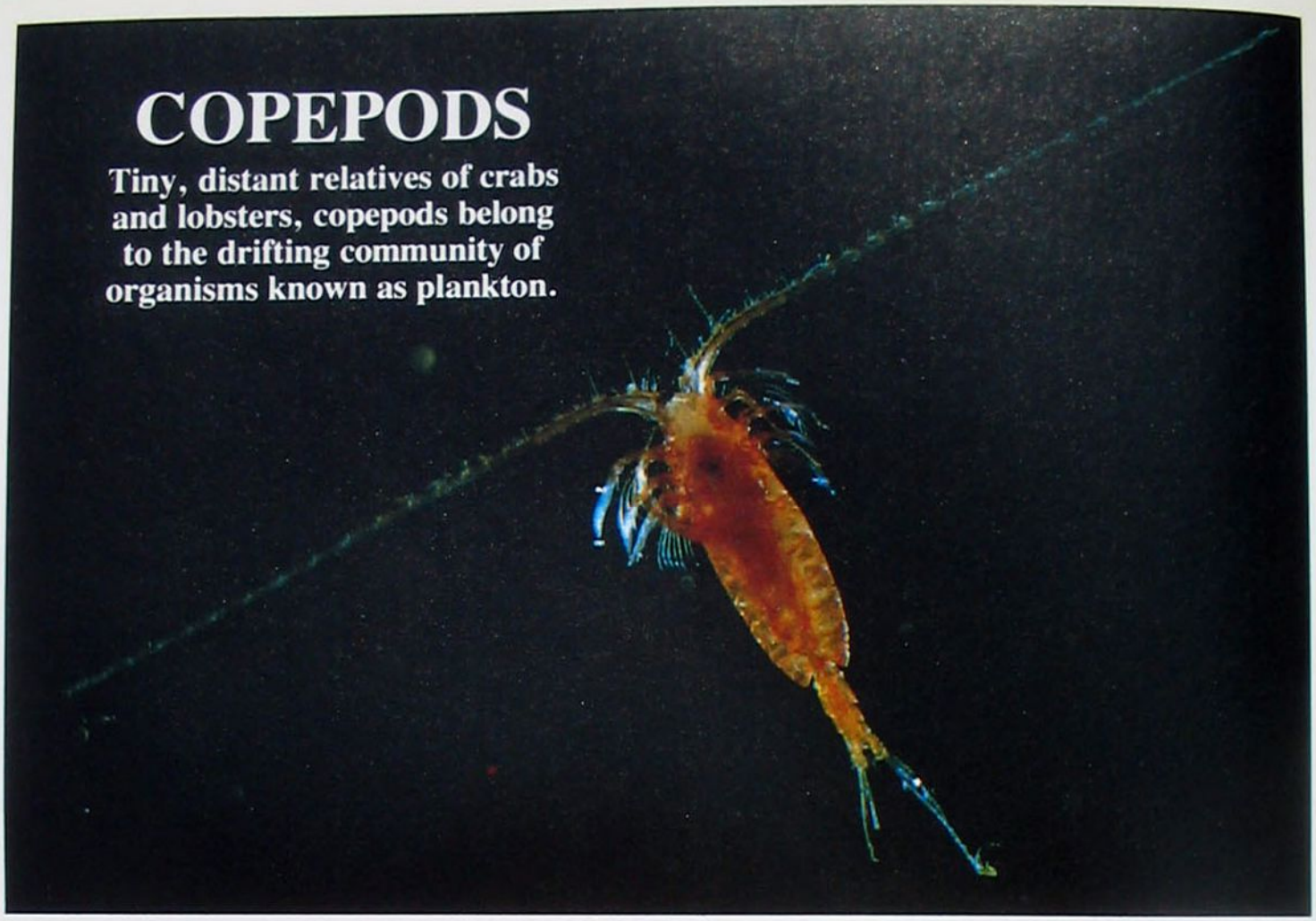
On the other hand, there are plenty of trees, such as oaks, which have had their trunks and upper boughs ivy-clad nearly all their long lives, and they still look totally healthy. And there is probably little competition between the roots of ivy and oak because they feed at different levels. Conservationists therefore tend to be much in favour of ivy, pointing to its great beauty in the landscape, especially in winter, and to its importance to wildlife.

A dead tree festooned with ivy (above), and the berries (below). Because of its clinging nature, ivy was thought to symbolise the closeness deemed desirable in marriage. It is still regarded as an emblem of constancy.

As far back as ancient Greek and Roman times, ivy has had an honourable place in folklore: on ceremonial occasions it decorated the arms and shields of warriors and was placed on the brows of poets. In religious ceremonies ivy was transferred long ago from pagan to Christian rituals, and used to be as essential to Christian decorations as holly is now, for it was credited with protective powers against witchcraft and other dangers. In literature ivy achieved popularity in the Romantic period when it became associated with the owl-haunted ruins featured in so many novels and poems. It thus became a symbol for solitude and melancholy.

COPEPODS

Tiny, distant relatives of crabs and lobsters, copepods belong to the drifting community of organisms known as plankton.



Copepods are small crustaceans that are found in both freshwater and sea water. Forming a major part of the plankton in the sea, they are very small, most of them growing no larger than 1mm in length. Although the majority of the species are free-living herbivores, feeding on the minute floating plant plankton (phytoplankton), some are parasites found mainly on fishes.

Scientists are not entirely in agreement about the classification of crustaceans, but there is no doubt that the copepods form an important part of the group. The marine copepods in particular are very numerous and nearly three hundred species have been recorded in British waters.

Swept-along swimmers Because the free-living copepods are so small, they are at the mercy of the water currents on the sea's surface. They cannot govern their horizontal movements, but they can maintain their vertical position in the water in order to keep among the phytoplankton on which they feed. They swim in a variety of ways. *Cyclops* is a freshwater form that used its front legs to move jerkily through the water, while some species swim by flexing and straightening their legs or bodies. The large first pair of antennae with their feathery outgrowths (see diagram) prevent the animals from sinking fast in the water: in fact, they work like a sort of parachute. The second, shorter, pair of antennae are used by some species to help in swimming.

Finding food Although the majority of free-living copepods feed on microscopic plants, using the limbs around the mouth to sieve out the particles from the surrounding water, this is not the only method of feeding. Some species explore surfaces of plants, rocks and sand in search of food. *Cyclops* is believed by some scientists to be able to catch animals larger than itself as well as to feed on decaying matter.

The parasitic copepods show various degrees of specialisation. Species such as *Lernaeocera* are highly modified for parasitic life, and they are unrecognisable as copepods at first sight. As adults, these animals have

Above: *Megacalanus* is a marine copepod which often occurs in huge numbers. It filter feeds on minute organisms such as protozoans and is itself food for fish such as herrings.

Below: The copepod *Lepeophtheirus*, sometimes known as the sea louse, is a parasite of salmon at sea and does not survive for long in fresh water. Feeding on the fish's tissues, it can cause considerable irritation to its host.

become superbly adapted for life on the gills or other parts of fishes where they suck the blood, causing damage to the sensitive tissues and greatly weakening the fish. As these copepods no longer need to lead an independent life the parts associated with movements have degenerated and the body structures concerned with holding on, feeding and reproduction have developed instead.

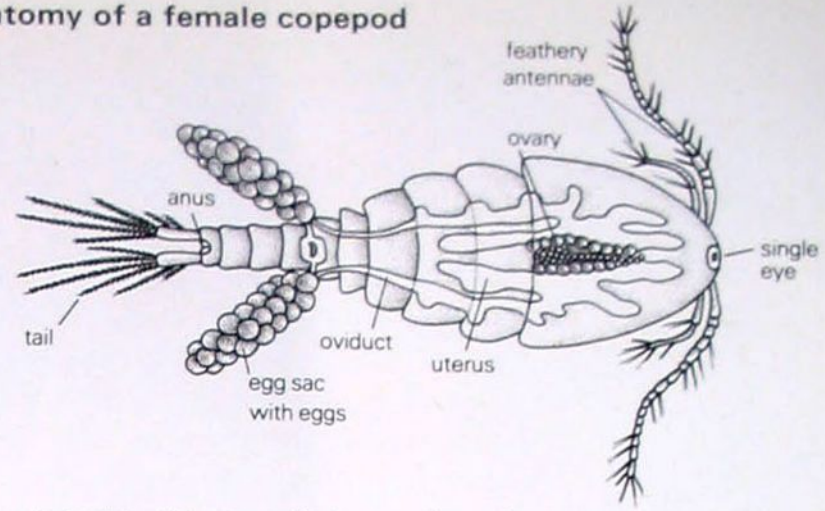
Reproductive adaptations Marine free-living copepods reproduce seasonally. The sexes are generally separate; the male produces a small packet of sperm and attaches it to the female's body to fertilise her eggs which are often laid in one or two egg sacs. The fertilised eggs hatch into larvae known as nauplii that are unlike their parents in appearance. The nauplii swim around in the surface waters, feeding and shedding their outer skeleton (moulting) at periodic intervals. They gradually change in form and growth as each moult leads them to resemble the adult form more closely. The nauplii of many species are scarcely visible to the human eye.

Many freshwater copepods, which have to survive the hazards of drought, a problem unknown to their marine relatives, have evolved a system of producing two different types of egg to combat the problems they face. One type of egg quickly develops after fertilisation and hatches into a new individual in less than a fortnight. The other type, often bigger than the first, may take a very long time to develop. This is because they lie on the bottom of the pond, where they are resistant to cold weather and drought and do not develop until the conditions are suitable again. These eggs may be picked up by fishes or birds and distributed from place to place. As a result, some copepods may seem to appear mysteriously in pools and ponds which have been dry for some time, and disappear again when the water dries up.

Parasitic marine copepods reproduce in a slightly different fashion. Their earliest larval stage is like that of a typical free-living copepod, which confirms that – despite their strange adult appearance – they really are copepods. However, much of their larval life is spent attached to a secondary host: a different species of fish from the one parasitised by the parent. Males and females eventually detach and mate during a free-moving phase, and then the female attaches herself to the gills of the primary host and assumes the adult form, producing thousands of fertile eggs. In *Lernaeocera*, for example, the adult female is found on the cod's gills, while both sexes of the developing larvae parasitise the flounder, again attaching themselves to the gills.

A valuable food supply The free-living marine copepods are the most important herbivores in the plankton. All life depends on sunlight for a source of energy, and in the oceans this sunlight is harnessed by chlorophyll in the myriads of drifting planktonic plants. It is this rich crop of plants, using sunlight and water-borne minerals, that produces carbohydrates and protein. The copepods 'graze' on these plants and a small volume of plankton may contain hundreds of copepods such as *Calanus*, which is preyed upon by fish that strain sea water for food through their gill rakers. One species in particular, the herring (*Clupea harengus*) feeds almost exclusively on copepods such as *Calanus*. This copepod is therefore very important in commercial fisheries. The abundance of the herring from year to year depends on the numbers and nutritional value of *Calanus*, which in turn depends on the abundance of plant plankton.

Anatomy of a female copepod

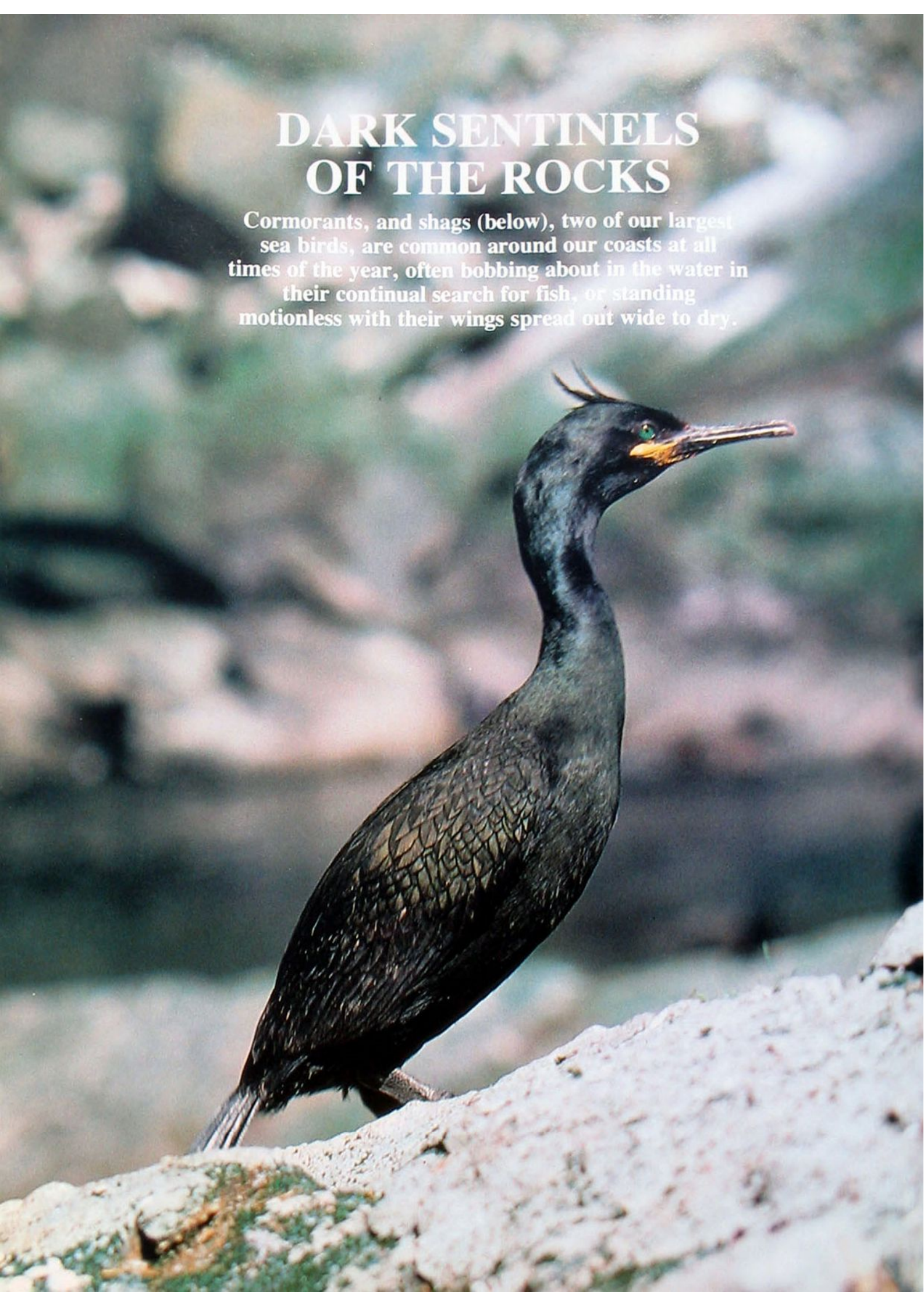


Cyclops (above), like most free-living copepods, has a single eye on its head, with two pairs of antennae on either side. The first pair of these is long and hairy, the second pair rather shorter. There are usually six limbs on the body, and the females often carry one or two egg sacs.

The eggs of the female *Cyclops* (below) are just hatching to reveal the nauplii larvae, which bear little resemblance to the adult.

DARK SENTINELS OF THE ROCKS

Cormorants, and shags (below), two of our largest sea birds, are common around our coasts at all times of the year, often bobbing about in the water in their continual search for fish, or standing motionless with their wings spread out wide to dry.



Groups of large, black, long-necked birds apparently just standing idly around, are a familiar sight on British coasts. They are cormorants and shags. Although totally dependent on diving in water to catch food, these birds have wing feathers that are less water repellent than those of most other water birds. After each feeding session they have to seek an open, breezy place and hang their saturated wings out to dry. At favourite loafing spots, such as low rocky ledges, islets, piers, breakwaters, moored boats and buoys, you can often see several birds standing in a row. Sandbanks exposed at low tide in estuaries are also often used.

Ancient birds The cormorant and shag family has one of the longest fossil records of all birds. Remains of one cormorant-like bird found in Hungary are thought to be 100 million years old. Today there are 31 species of cormorants and shags in the world, including a flightless species found only in the Galapagos Islands.

In the British Isles we have only two species, and shags outnumber cormorants by about four to one. Our species of cormorant has an extensive world distribution and lives in every continent except South America. In contrast, our shag is restricted to Europe and North Africa.

Near-black look-alikes Even experienced ornithologists sometimes have difficulty distinguishing between shags and cormorants. Of the two species, the shag is smaller and slighter, with a narrower beak. Neither species is really black: shags have glossy green-black underparts and a brownish tinge to their wings and back. Cormorants have white cheeks and chins.

In summer, identification of adults is easier, since both species develop temporary breeding plumage. Shags grow a characteristic recurved crest about 5cm (2in) long. Cormorants grow whitish wispy feathers on their heads, and a white patch on each thigh which is often conspicuous in flight.

Immature shags and cormorants have brown upperparts. Young shags may only be a little paler beneath, whereas young cormorants can be almost white. The plumage of both species becomes darker with each successive moult until they reach full adult plumage in the second or third year.

In common with their close relatives, the pelicans, gannets and frigate birds, shags and cormorants have patches of bare skin around the beak and eyes. These are analogous to the pelican's enormous fish-carrying pouch. *Phalacrocorax*, the Latin name for shags and cormorants, refers to these patches, and means 'bald raven'. The name cormorant is apparently an English corruption of the Latin *Corvus marinus*, or sea crow.

In general shape and habits both species resemble divers. However, in the water you can easily spot cormorants and shags by their

Shag
(Phalacrocorax aristotelis);
76cm (30in) from beak to tail. Found all round the coast of the British Isles and occasionally inland. Population currently on the increase. Resident.

Cormorant
(Phalacrocorax carbo);
90cm (36in) from beak to tail. Less common than the shag, but more widespread, being found inland as well as around our coast. Resident.

Below: Cormorants breed in colonies, often in very exposed sites where storms can be disastrous. Eggs or young are easily chilled by sea spray and whole nests can be washed away by the waves.

Cormorant display postures

Cormorants and shags perform elaborate displays at their nest sites. The male cormorant, having claimed a suitable site, advertises to prospective mates by a series of dramatic gestures such as spreading his head feathers and raising his long wedge-shaped tail (**1**), calling with head and bill thrown back (**2**), and by rotating his head noisily from side to side whilst touching the base of the tail with his closed beak (**3**).

long, thin, upstretched necks and narrow, hooked beaks which they hold up at an angle. In flight they hold their necks horizontally or slightly raised, while divers allow their necks to droop below body level.

Low-lying swimmers As you would expect, most water birds are waterproof. However, cormorants and shags probably find their lack of waterproofing advantageous. On entering the water they expel air from their feathers and so increase their overall density, becoming heavier and therefore diving more easily. Both species tend to swim low in the water with their backs just awash, and when they are afraid of attack by predators they sink until only the head and neck are visible. Nevertheless, they cannot stay in the water indefinitely, and always remain within reach of land where they sleep, preen and dry out. Unlike many other sea birds, cormorants and shags are never oceanic.

Below: A shag parent with its chicks in a typically defensive posture, its long neck outstretched as it utters a loud call, and its wings held slightly away from its body.

Cormorants and shags are powerful swimmers, both above and below water. For maximum efficiency in the water their legs are placed well back along the body, but this means they are poor walkers on land. Most water birds have a small hind toe that is useless for swimming. However, the hind toe of cormorants and shags is long, turned inwards and webbed to the inside front toe, giving them three webs instead of the usual two on each foot. Their close relatives also have this pattern of webbing.

These species are two of our largest sea birds and in calm weather without the help of the wind they have difficulty in rising from the surface of the water. However, once they are airborne, their flight is powerful, with steady wing-beats and neck outstretched. They usually fly in a straight line low over the water. In silhouette they resemble geese, and if flying far, perhaps to good feeding areas or back to communal roosting sites, they often travel in lines or a goose-like V formation. Cormorants also fly inland, sometimes soaring to a great height. They follow river valleys where they find lakes and slow moving rivers.

Vicious fishers If you watch cormorants and shags fishing you will probably be able to spot their catch. They actively pursue fish beneath the water; once grabbed by the strong, hooked beak the fish has little chance of escape. The birds usually return to the surface to swallow their prey, and often juggle the fish in their beaks to be sure it goes down head, not spines, first.

In the past these birds were accused of depleting fish stocks–a cormorant eats up to 700g (1½lb) a day–and thousands were shot. However, studies show their feeding habits are rarely detrimental, although in fresh water they may take the occasional trout as well as eels, perch and young salmon. In some places the birds may be beneficial, helping to control the predatory fish which

would otherwise eat species more favoured by man.

On the coast cormorants prefer shallow bays and estuaries where they dive to catch flatfish such as flounders. They also eat cod and whiting, and shore fish such as blennies.

Typically the nest is a heap of seaweed, bracken and heather. Both sexes build, although the male often concentrates on collecting the material and the female on arranging it. The species may nest singly, in scattered groups or in large colonies (rookeries) and you may find all three types together. In a colony, nests may be almost touching, though usually they are just out of pecking distance. There are fights for the best sites when two opponents grab each other by the beak and try to pull or push the other.

The females lay three or four eggs in April or May, usually at two or three day intervals. The eggs are pale blue and covered with a chalky deposit. Storms can destroy many eggs and chicks and pairs may have to build a new nest and lay a second clutch. The timing of the breeding season partly depends on the food supply; in Wales shags have been found breeding in winter.

Both parents incubate the eggs in 12-hourly shifts, each fearlessly defending the clutch against marauding gulls. Many species develop a brood patch (an area of skin on the belly without feathers but well supplied with blood vessels to keep the eggs warm). Shags and cormorants, however, have warm feet that they shuffle beneath the eggs during incubation.

Shags fish only in the sea. They swim in deeper water than cormorants catching mid-water fish such as sand-eels, sprats, whiting and saithe. They rarely eat flatfish.

Coastal nests In the British Isles cormorants and shags nest on rocky coasts. There are a few in southern and eastern England but most are found in Scotland. Cormorants favour small rocky islands and broad cliff edges, their nests up to a metre (3ft) wide and over 80cm (2½ft) high. Some nest inland, and in Ireland they nest in trees, a habit widespread elsewhere in Europe that was more common in this country before persecution took its toll. Shags prefer more sheltered coastal sites such as crevices in rocky gullies, ledges in the roofs of caves or among boulders on steep slopes. They can nest on a ledge only 30cm (1ft) square. Both nests and surrounding rocks become plastered with odorous white droppings (guano). However, it makes excellent fertilizer and is collected for this purpose in many parts of the world.

The first egg hatches after a month, and for almost a week the nestlings are blind. Each parent feeds them once a day on a diet of regurgitated fish. The young birds leave the nest after about seven weeks and become independent about two months later.

Both species disperse a few hundred miles during their first winter. They breed when they are two or three years old, often in their natal colony. After this they are relatively sedentary.

Above: A juvenile shag in a rock pool. Young birds are dark brown, and they do not have paler underparts like young cormorants.

Compared with many birds, shags and cormorants are long-lived. Of those that survive the first few years, only 10-20% die in each subsequent year. Their average life expectancy has been estimated at about seven years, but some live to be 20 years old.

Both species were heavily persecuted in the last century, and even now many are shot each year. Some become entangled in fishing nets and others suffer from oil from ships washed ashore. Nevertheless, the shag, and probably also the cormorant, are currently on the increase.

BRITAIN'S BLOOMING BRASSICAS

Britain has an ideal climate for most brassicas – the members of the cabbage family. Among them, Brussels sprouts, cabbages and cauliflower all produce a fine winter harvest.

Cabbages, kale, broccoli, Brussels sprouts and cauliflower all belong to the same species, *Brassica oleracea* (meaning, not unreasonably, edible cabbage). Wild forms of this species occur on sea cliffs in many parts of Britain; they are large, perennial, kale-like plants with attractive yellow flowers and a hotter, more bitter flavour than the cultivated forms.

The cultivated brassicas originated several thousand years ago: cabbages in western Europe, broccolis in the Eastern Mediterranean; and various varieties of kale throughout Europe. The extensive trading network of ancient Greek and Roman times resulted in the different forms being brought together; they cross-pollinated, thus generating further varieties.

Brussels sprouts The Brussels sprout was developed from the cabbage rather later – about 300 years ago – in Belgium. Within the last 150 years it has become a British favourite and we probably grow and eat more than the rest of Europe put together. The two main traditional areas for sprout growing are the Vale of Evesham and Bedfordshire. The methods of growing remain much as of old although the type of plant grown today has to conform to the standards of supermarkets and freezing companies, rather than the old local standards. The Vale has remained a typically English patchwork of small fields with mixed market gardening. The sprouts are still picked in the field here, but in Bedfordshire the traditional methods have changed: the sprouts are harvested on their stalks, to be stripped by mechanical knives before despatch to the freezing factories.

Cauliflowers Two distinct forms of cauliflower – developed from broccoli – came to us in the 16th to 18th centuries. The summer-maturing type was developed in Germany and Denmark and was always referred to as the 'cauliflower'. The winter and spring-maturing types were brought here from Italy and retained their ancestral name of 'broccoli'. As a result, the terms 'cauliflower' and 'broccoli' were used for two crops which looked identical. Today, all the white, head-

Above: Savoy cabbage *(Brassica oleracea* var. *bullata)* is an autumn and winter vegetable with a fresh green colouring and distinctive tightly wrinkled leaves. Cabbages are rather easier to grow than sprouts and cauliflowers and there are many varieties, from the solid compact heads of the Dutch white storage cabbage to the loose pointed heads known as 'spring greens'.

Below: Kohl rabi *(Brassica oleracea* var. *caulorapa)* is sometimes called the turnip-cabbage. The purple or white swollen stem provides the edible part of the plant, with a flavour similar to that of the turnip.

ing types are referred to as cauliflowers, while the name broccoli is kept for sprouting forms and those with green or purple heads.

The growth of the cauliflower industry in this country was due largely to the Industrial Revolution, when railways made the cities accessible for growers of fresh produce. Cauliflower growing areas developed near the coast, where winter temperatures are kept higher than usual by the sea, for the cauliflower is the least resilient of all the brassicas and is the most difficult to grow. Coastal Kent, Cornwall, and Hampshire were the growing areas for winter cauliflowers, while the hardier, spring types were developed in inland areas from the Midlands to Yorkshire.

Several of the old types of winter and spring cauliflowers, and a couple of the traditional growing areas, have now gone. Most cauliflowers, especially autumn varieties recently bred in Australia, are now grown on a large scale in Lincolnshire. Changes still take place; the most recent is the reduction in the last 15 years of output from south-west Britain. The decline of the railways, the increase in road freight costs, and competition from France, have all contributed to a contraction of the Cornish cauliflower industry.

Cabbages have probably been grown in Britain since before the 5th century. With their non-heading cousins, the kales, they were valued in medieval times for their medicinal properties. However, in this respect, they probably had no more value than any other green vegetables, except that they were available in the 'hungry gap' between midwinter and early spring. Despite being one of the most productive and reliable of vegetables, they have tended to decline in popularity as prosperity has increased.

Cabbages are rather easier to grow than other brassicas and therefore they are not produced in specialist areas. The exception is the loose pointed cabbage sold as 'spring greens', which is concentrated in coastal Cornwall, Kent and the Vale of Evesham so it is ready in time to exploit the lucrative early spring market.

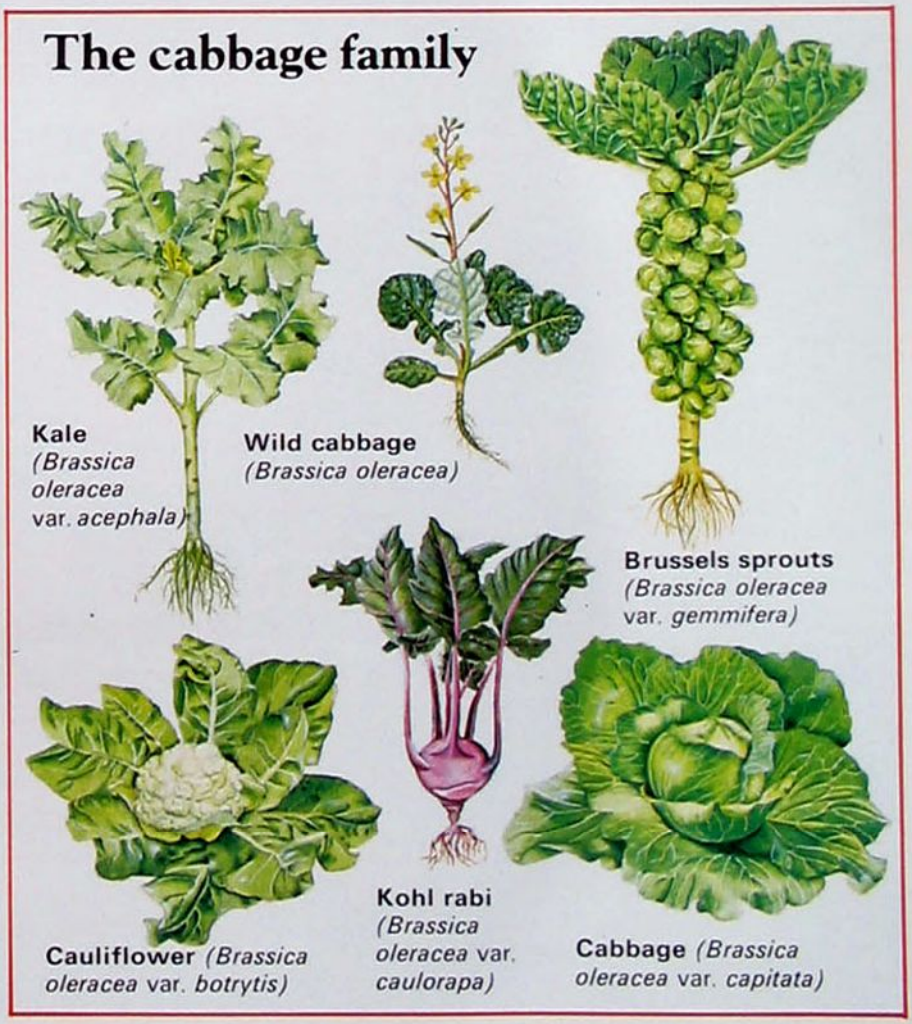
The dense-headed Dutch white storage cabbage has recently been introduced to this country. Used in north European countries for sauerkraut and eaten raw in Britain as coleslaw, it was planted by Lincolnshire growers in the 1960s and is the only cabbage that is increasing in popularity. Harvesting of the cannonball-like heads starts in October, and in November or December the grower cuts all the remaining heads, keeping them in a cool barn until as late as April.

Minor cabbage crops Among the other forms of brassica which are grown in Britain are the broccolis. Green sprouting broccoli (calabrese or broccoli spears) is an important frozen vegetable in America, and is starting to be grown for the same purpose here, usually near the processing factories in Scotland and Humberside. The spring-maturing purple sprouting, white sprouting and Cape broccolis are grown in gardens and allotments rather than commercially, for they tend to be of very variable quality and quickly discolour after harvesting. However, increasing interest in broccoli by growers and supermarkets means that it is likely to become an important vegetable in the next few years.

Kale is unlikely to regain its importance as a food for humans, but it is very often grown purely as a fodder crop for cattle to graze. Although we may have lost one food to cattle, kohl rabi, used as animal fodder in Europe, is becoming popular instead.

Above: Sprout picking in the snow. The British climate normally has cool winters which means that damage to the brassica crops from severe frosts is uncommon. In fact, Brussels sprouts, like Savoy cabbage, taste better after the first frosts of winter.

Below: These familiar members of the cabbage family are all descendants of the wild cabbage, cultivated as a food plant in Britain for centuries.


The cabbage family
Kale (Brassica oleracea var. acephala)
Wild cabbage (Brassica oleracea)
Brussels sprouts (Brassica oleracea var. gemmifera)
Cauliflower (Brassica oleracea var. botrytis)
Kohl rabi (Brassica oleracea var. caulorapa)
Cabbage (Brassica oleracea var. capitata)

SOUND SENSE IN MAMMALS

Stags roar, whales sing, dolphins click and mice squeak. The sounds that mammals make are vital for their survival, and each species has specialised ears designed to pick up not only the calls of its own kind, but also those of enemies.

Below: Repeated roaring by a red deer during the rut causes hinds within range to move into his mating territory and form a harem. His belligerent bellowing also warns rival stags to keep out, although fights still occur.

Most British mammals are normally heard rather than seen and, because they are most active at night, it is during the hours of darkness that they are at their most vocal. The sense of hearing in mammals is acute, allowing them to hear from a fair distance, enemies approaching or the call of their offspring or partners. Depending on the species, the sounds they make range from yelps and growls to high pitched squeals and drawn out rumbles. Some mammals, such as bats, even make sounds that are inaudible to the human ear but can be heard by members of their own kind.

Of all mammal senses, that of hearing is probably the most versatile. A mammal can receive messages from other animals hidden by undergrowth, trees, or darkness, and sounds can also warn of approaching danger even when nothing is visible. The passage of sound through the air can be deadened by poor weather conditions, such as mist, or lost in a strong wind, but a breeze often carries sounds over longer distances.

Warning noises When an animal makes a sound it gives its presence away to other animals, some of which may be predators or potential prey. As a result, many wild mammals spend more time listening than making sounds. In particular, they listen for the alarm calls of other animals–birds, for instance, give warning of danger long before the mammals on the ground are aware of it.

When the keen ears of a rabbit detect the approach of a fox, the rabbit immediately alerts others by thumping a hind foot on the ground. The reaction of the other rabbits varies with the intensity of the sound–loud thumping means the danger is very close, and usually results in all the rabbits dashing to the warren.

Sound for talking Sometimes it is necessary for animals to communicate vocally with members of their own species. Some mammals are very noisy during the breeding season–the need to find a mate overrides the fear of detection. The red deer stag is silent most of the year, but during the rutting season he finds good vantage points and roars over his mating territory to attract hinds to come into his harem. Dog foxes and vixens also call to each other in nightly spring courtship rituals, using the familiar eerie yelping bark.

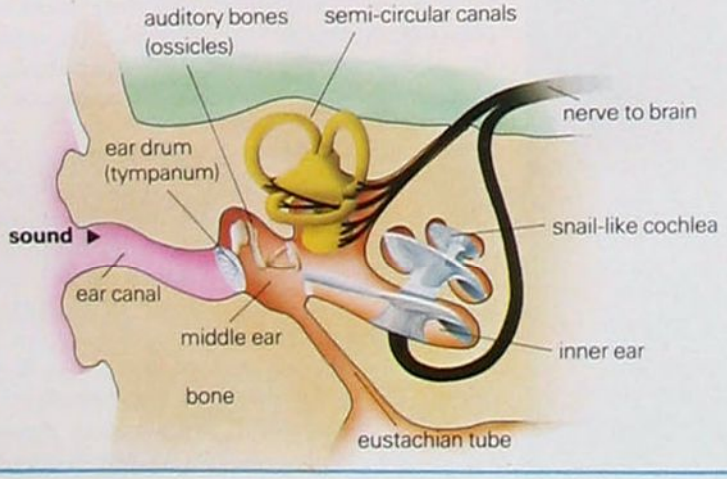
Baby talk Hearing is most important to a mammal mother and her new-born young. Many babies–for example, rodents such as rats and mice, and carnivores such as foxes and stoats–are rather helpless when first born. Initially their senses are poorly developed, but they squeak instinctively when they are distressed in any way. The noises they make stimulate their mother to retrieve any that may have strayed from the safety of the nest; feed any that are hungry; or groom any that are dirty.

Sounds under water The ears of most mammals are designed for hearing air-borne sounds; when a mammal spends some, or all, of its life in water the ears are modified to meet the problems this causes. Semi-aquatic mammals, such as the otter, spend much of their time out of water and have fairly typical mammalian ears, although their external ears (pinnae) are small and neat, which helps to streamline the body.

In the common and Atlantic seals the streamlining process is taken much further –there are no pinnae at all. The entrance to the inner ear is merely an opening on each side of the head. Special muscles close off the ear canal when the animal goes under water. As in many animals, sound is important to

Above: The otter is streamlined for its semi-aquatic life style; it is aided by the fact that its external ears are small and can be made to lie close to its head when it is swimming. Thus they do not impede the animal's swimming movement.

Right: Most mammals are able to move their ears independently of each other. This allows the animal to pick up sounds from all directions while it stays motionless–and usually undetected by enemies or prey. Here a fox pricks up its ears–no doubt hearing the photographer at work.

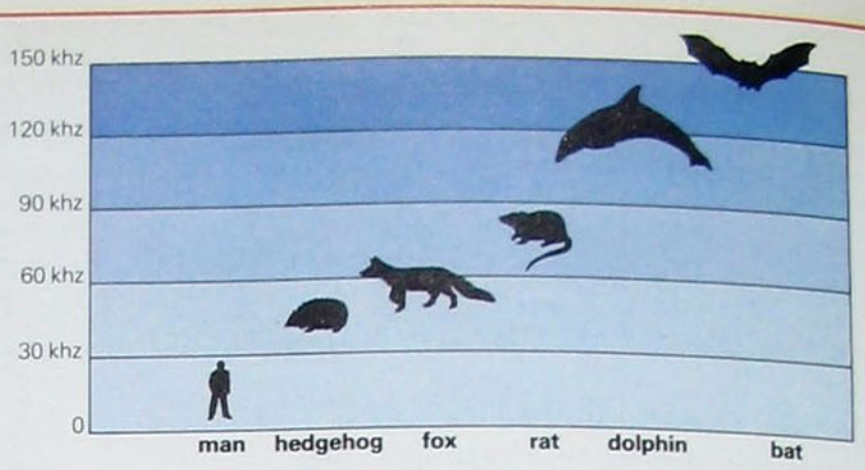


The ear of a mammal

A feature of most mammals–unlike birds, reptiles, amphibians and fish–is the two external ears, called pinnae, situated on the head. Each pinna has special muscles that move the ear in different directions in order to catch sound waves and direct them down the ear canal. These sound waves set the ear drum vibrating, and these vibrations are transmitted via the auditory bones to the fluid-filled, snail-like cochlea. The cochlea contains sensory hairs which respond to the vibrations and transmit messages to the brain, along the auditory nerve, where they are interpreted as sound.

Highs and lows in hearing

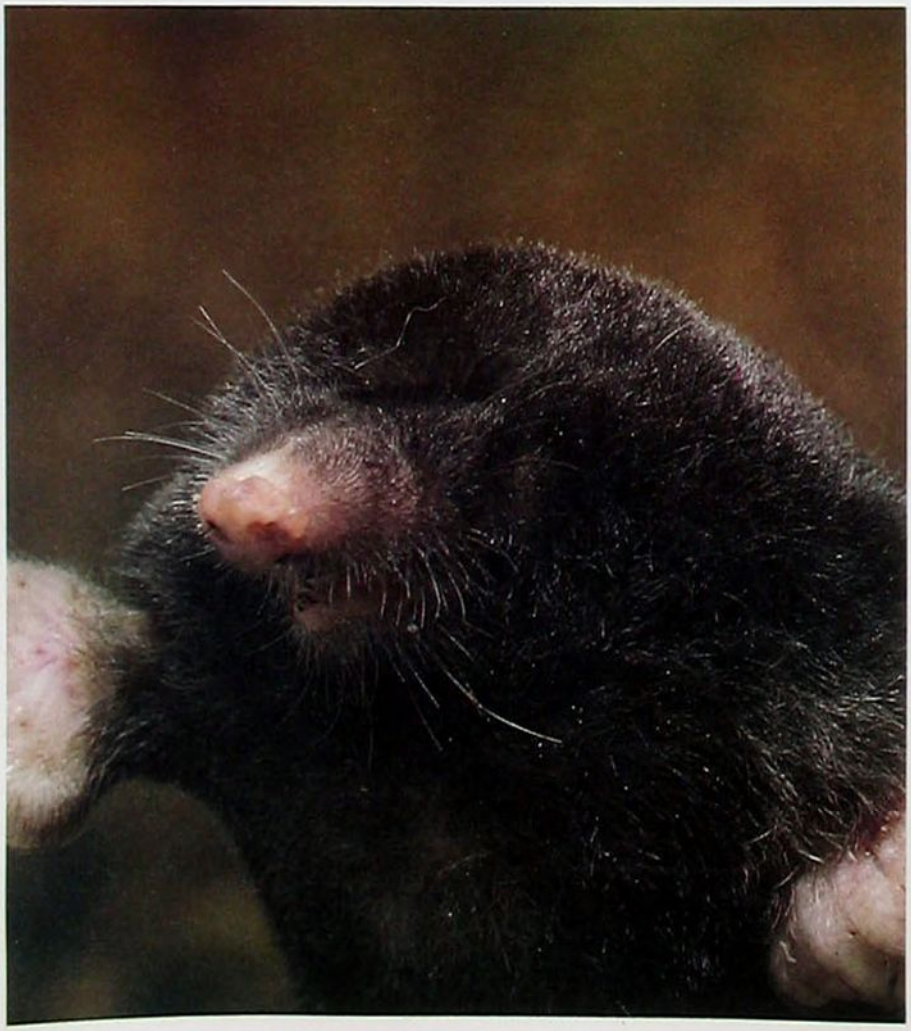
It is difficult to imagine the sounds that some of man's mammalian relatives can hear. A bat can hear sounds of frequencies beyond 100kHz, whereas the human ear can only hear up to 20kHz. A kilohertz (kHz) is a unit of vibration frequency, one kHz equalling 1000 cycles per second. When a human ear picks up the sound of someone walking through dry fallen autumn leaves in the dark, the sound appears to the human ear as little more than a rustle. However, the sounds are also rich in high frequencies which are heard by small mammals as loud crackling sounds, warning them of danger.



seals for keeping contact with each other both in and out of water. In the breeding season, when the seal leaves the water, hearing helps it find a mate, avoid fights, and locate its young. This is important since the seal's eyes, although excellent for seeing under water, give a blurred view of life on land.

Dolphin clicks Dolphins are sociable animals that communicate with each other and find their food and their way about by producing sounds through a special technique called echolocation. The dolphin produces clicks, and listens for echoes. The returning echoes may indicate a shoal of fish or an obstacle in the dolphin's path. As the sounds are confined to a life under the water, the dolphin's ear has become specialised for hearing only water-borne sound.

Below: The mole has no pinna or external ear, an adaptation to life underground. The structure of its internal ear suggests it does not have particularly good hearing as its sound-sensitive cochlea has only one and three quarter turns—probably the shortest found in any mammal. A bat has nearly twice this number. However, a mole undoubtedly hears. A captive mole has been taught to come to feed when a bell is rung.



Hearing underground The mole, which spends most of its life underground, has very small ears that do not interfere with its burrowing. Its ear canal can be shut off by muscles so that debris does not enter them. The mole's minute eyes are not very sensitive to light—a bright light shone into the eye of a mole causes no reaction—but the mammal reacts by moving if a sound is made. This would suggest that the mole's sense of hearing is more important than its eyesight. Most of the sound that reaches a mole in its tunnel is transmitted through the soil, and consists of low frequency vibrations.

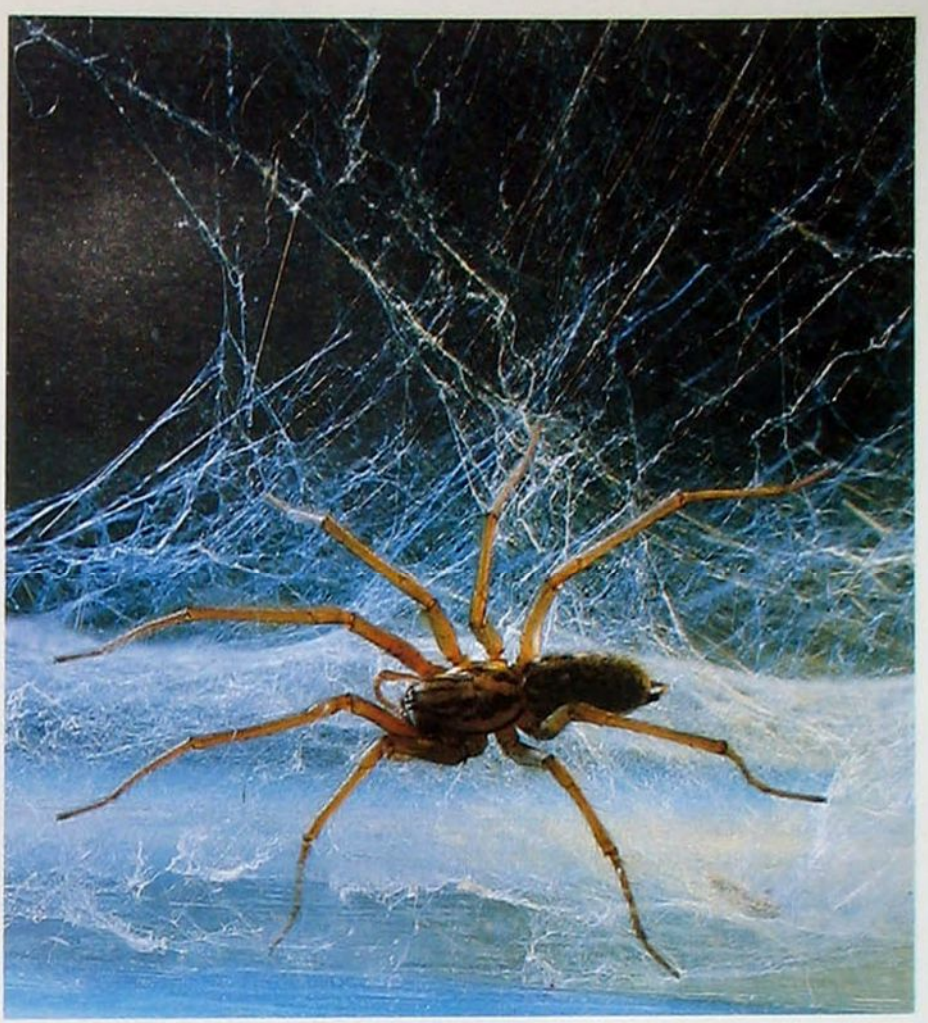
A mole is an unsociable creature and when it meets another mole they both make loud noises, including high-pitched squeals. Their sounds probably determine who has the right of way through the tunnel, and may also help to find a partner in the breeding season.

High frequency hearing is best developed in the smallest mammals. High frequency sounds consist of very short wavelengths. If a baby rat or mouse is removed from its nest its flanks move deeply in and out, and its mouth opens wide, yet no sound is heard by a human ear. In fact, the baby rodent is making squeaking noises, but they are at very high frequencies of up to 70 kilohertz. Although the human ear is not sensitive to these wavelengths, the mother hears them and responds to them. Such high-pitched sounds are also a safety measure for the babies, in that most would-be predators cannot usually hear these sounds.

Bats are able to detect sounds of very high frequency. The part of their brain associated with hearing is remarkably well developed; in fact, hearing is by far the best developed sense in bats. Like a dolphin, a bat uses echolocation, emitting 'pulses' of high frequency sound and listening for the echoes so that it can identify any object in its flight path, such as an insect or the branch of a tree. The horseshoe bat emits and detects pulses of 110 kilohertz frequency.

SPIDERS THAT HAUNT OUR HOUSES

About six or seven spiders habitually live inside houses, notably the large species that runs across the floor at night, and the one you find in the bathtub in the morning.



Above: House spider of the genus *Tegenaria,* with its sheet web. These spiders make the cobwebs which festoon ceilings that are not swept regularly. The sheet webs, although very different in appearance from the beautiful orb webs of the garden spider, have the same purpose—to entangle and capture flies.

People who live in the temperate and colder parts of the world spend most of their lives in an artificial climate—that of the houses in which they dwell. Conditions are warmer and much drier indoors than outside, and also more uniform throughout the year. About half a dozen species of spider live in houses in Britain and Ireland. The majority of these do not normally live out of doors in this country, but are natives of warm, dry climates such as that of the Mediterranean. Probably carried across the world in the holds of cargo ships, these spiders have colonized human dwellings far to the north of their native homes.

Most of the spiders you find are females, which are the dominant sex. The males are usually smaller and most of them approach their prospective partners with extreme caution. If the female is not in a receptive state of mind she is quite likely to treat an approaching male as a meal rather than as a suitor. House spiders, like all spiders, feed by injecting digestive fluid into the body of the prey and sucking back the resulting solution. The pair of jaws through which the poison is injected when the spider bites are called chelicerae.

Sheet-cobweb spiders The largest and most familiar of the house spiders belong to the genus *Tegenaria*. Those you often see sprinting across the floor at night in the autumn are males looking for females.

Tegenaria domestica is the smallest and lightest in colour of the three house-haunting species. It lives in houses in most parts of the world, but is occasionally found out of doors in Britain in sheltered places such as caves. This spider usually hangs the white silk cocoons than contain its eggs from a ledge near its thick, rather opaque web.

Tegenaria gigantea is larger than *T. domestica*, and with more distinct dark body bars on the abdomen. Also the female's web is flimsier and the egg cocoons are fastened flat against a wall beside the web. In southern Britain *T. gigantea* is common in houses, but becomes less so further north. This is the least house-bound of the three species, and is fairly common on banks and walls out of doors, especially in the south-west. Many of these outdoor individuals make their way into houses in the autumn.

The third species, *Tegenaria parietina*, is about the same size as *T. gigantea* but has longer, hairier legs, and there is often a reddish-brown band along the centre of the abdomen. It is restricted to houses in southern England. The female hides her white egg cocoon inside her web. This species is sometimes called the 'cardinal' spider, from the

Top view of a spider

A spider's body is divided into two parts: a combined head and thorax—the cephalothorax—and an abdomen. The cephalothorax is covered by a chitinous 'plate'—the carapace. It has four pairs of legs and a pair of jaws (the chelicerae), as well as palpi, or feelers, which are swollen in males and used to transfer sperm to the females. Some large house spiders can bite humans, but cause no more than a temporary irritation.

Below: *Tegenaria domestica*. Reaches a body length of 10mm (⅜in).

Above: *Tegenaria gigantea*. Has a length of up to 18mm (⅝in).

Below: *Tegenaria parietina*. body length 11-14mm (½in).

Above: *Herpyllus blackwalli*. Reaches a body length of 11mm (½in).

Below: *Oonops domesticus*. Tiny pink spider 2mm (1/12in) in length.

Above: Five fairly common house spiders. Males are usually less obvious and smaller than the females.

Below: *Tegenaria* house spider. It has just moulted its skin (you can see the shrivelled old skin to the left of the spider). Spiders moult a number of times before becoming adult a year or so after hatching. Long-lived adults, like *Tegenaria*, may also moult once a year.

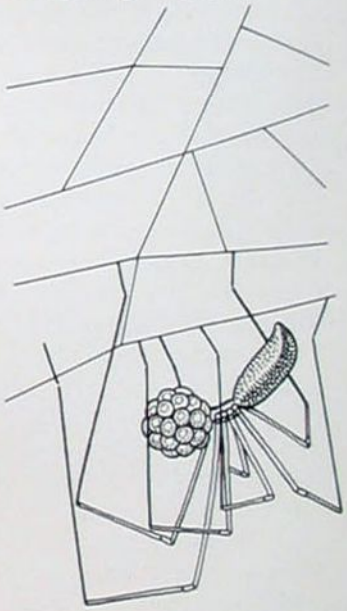
legend that Cardinal Wolsey was frightened by them when he lived at Hampton Court. One would have expected more spiritual fortitude from so eminent an ecclesiastic!

Long-legged spider The 'daddy long-legs' spider *(Pholcus phalangoides)* is still fairly common in the south of England, but its numbers have been reduced by the increase in central heating, which produces an atmosphere too dry for its existence.

The cephalothorax in *Pholcus* is small and rounded and the abdomen cylindrical, while the legs are extremely long and slender. The web consists of a sort of scaffolding of threads so fine as to be invisible to human eyes, spun in a ceiling corner. When an insect becomes entangled in them the spider bundles it up in a parcel of silk before killing it and feeding on it. Sometimes the spider rapidly shakes the web, which increases the entanglement of the small insect, while shaking free an unsuitably large one. The ends of the long legs are used in manipulating the silk, so the spider keeps its body well out of range of injury from the victim's struggles. The female is less predatory in her attitude towards the opposite sex than most spiders, and the male may remain in her web for a day or two after mating.

The late Dr Bristowe conducted a special survey in southern England, to determine the northern limit of *Pholcus* in Britain. On the

The daddy long-legs spider



Above: The daddy long-legs spider *(Pholcus phalangoides)* spins a scaffolding-like web in a ceiling corner. The female carries her egg sac, held together by a few threads, in her chelicerae. The first batch of eggs is laid in June, followed by second and third batches in July and August.

pretext of seeking accommodation he gained entrance to a variety of lodging houses and carefully inspected as many rooms as possible for evidence of spiders' webs before departing with polite expressions of dissatisfaction. He found that the line south of which *Pholcus* is commonly seen runs roughly east and west a little south of London. The spider is entirely confined to houses.

The mouse spider Dr Bristowe suggested the name 'mouse' spider for *Herpyllus blackwalli* on account of its glossy grey abdomen. This spider is widely distributed in Britain and Ireland and mainly, but not entirely, confined to houses. Since it hides by day and hunts by night, the mouse spider is not very often seen, but it sometimes falls into the bath-tub and is found there in the morning since it cannot climb up the slippery sides.

The mouse spider's method of hunting is simply to creep about at night on walls and ceilings, pouncing on any flies or moths that it encounters. This would seem to be a precarious mode of subsistence, but possibly *Herpyllus* has some sensory perception, not yet explained, that aids its hunting. It can go without water for months and eats dead insects – even butterflies left on lepidopterists' carelessly exposed setting boards. There is usually sparring and even fighting when a male woos a female mouse spider.

Pink prowler The least noticed of all the common house spiders is *Oonops domesticus*, a tiny pink or orange-brown spider only 2mm long. It is confined to houses and, like the mouse spider, hides by day and hunts by night, so it is hardly surprising that most people are quite unaware of its existence. Its prowling walk has been described as a 'slow, smooth, groping progress' so characteristic that it can be recognised several feet away, but it can dart forward when necessary.

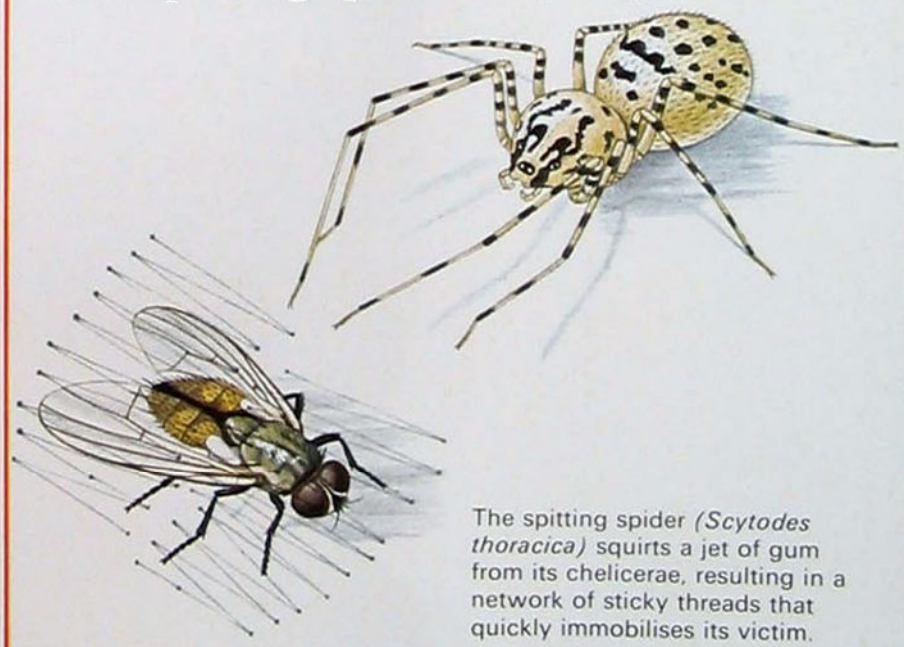
Oonops hides by day in a small silk cell; its eggs are wrapped in a silk cocoon concealed in the cell. Some species of spider wrap up batches of several hundred eggs in each cocoon, others lay clutches of 20 or less, but one of the oddest features of *Oonops* is that it lays its eggs in clutches of two at a time.

The spitting spider The least common of the house spiders is the remarkable spitting spider *Scytodes thoracica*. It is related to the daddy long-legs spider and has the same features of a rounded cephalothorax and slender legs, but the latter are not so disproportionately long. The coloration is distinctive – yellow with a pattern of black spots. In Britain it is confined to houses in the southern half of England. It is a long-lived spider, taking two to three years to mature and living another year or two as an adult.

Like the last two species, *Scytodes* hunts by prowling at night. When a victim is located the spider approaches to within a centimetre (about $\frac{1}{2}$in) or less and appears to jerk its head. The insect is instantly immobilised. What actually happens is that the cephalothorax is rapidly vibrated from side to side and, at the same time, a jet of gum is squirted from the chelicerae. This results in a network of sticky threads falling on the insect, rather like a fisherman casting a net, and completely pinning it down. The spider then advances and bites its victim repeatedly, retreating after each bite. Finally the spider drags its victim free of the threads and devours it. The threads that immobilise the prey are wholly distinct from the silk spun by all spiders which is drawn from the spinnerets at the hind end of the body. The eggs that a *Scytodes* female carries under her body are put aside when she catches an insect.

Above: *Amaurobius similis* is a common spider often found on the walls of a dry shed or outhouse; in autumn it wanders into houses, but is not an all-year round house dweller. The female lays eggs in June and July, and the males mature in late summer of the following year.

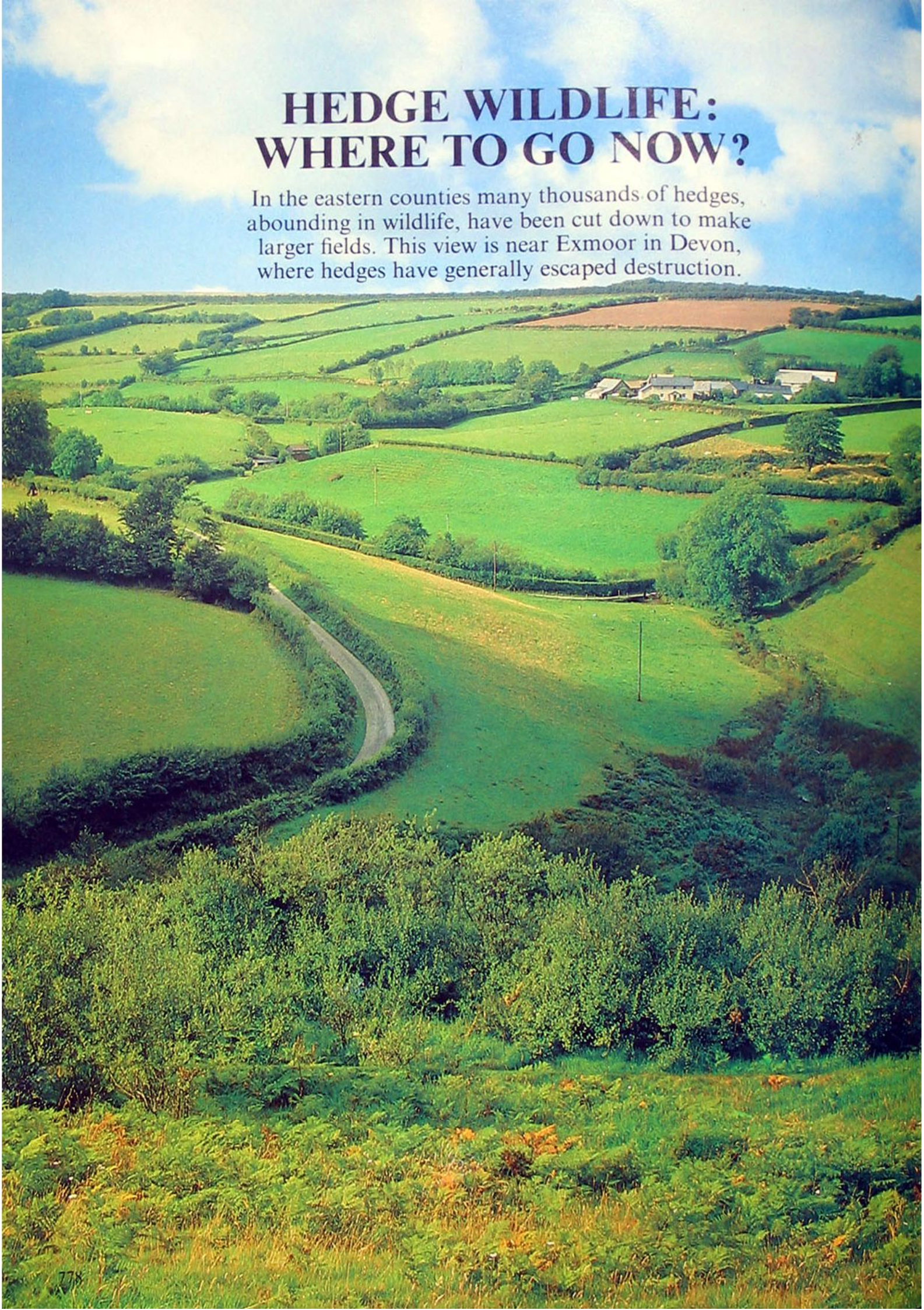
The spitting spider's fly trap



The spitting spider *(Scytodes thoracica)* squirts a jet of gum from its chelicerae, resulting in a network of sticky threads that quickly immobilises its victim.

HEDGE WILDLIFE: WHERE TO GO NOW?

In the eastern counties many thousands of hedges, abounding in wildlife, have been cut down to make larger fields. This view is near Exmoor in Devon, where hedges have generally escaped destruction.



Hedgerows are a prominent and distinctive feature of the British landscape, particularly in the lowlands. The oldest hedges are probably remnants of the continuous woodland that once covered most of Britain. As villagers and landowners cleared the forest for agriculture, they would leave the last few feet of forest standing to mark the outer boundaries of their domains. Today, some of our most ancient hedges are the remnants of such boundaries perhaps even now marking a parish border. Hedges were also formed to enclose patches of land to contain domestic animals. This would have been done close to the buildings of farm or village, and in many places these small, irregular enclosures can be seen today. They indicate old field patterns and ancient hedgerow.

Creating hedges For many centuries crops were grown in large, open fields which were divided into small strips. Each of these strips was tilled separately in an 'open-plan', communal style of farming. There was no need to fence off the arable land and divide it into sections with hedges. Gradually, however, the old system changed, patches of land being enclosed and assigned to individuals. The main period of enclosure was the century between 1750 and 1850, during which Parliament passed a series of acts empowering landowners to add to their estates large areas of what had previously been common land. Rapid carving-up of the landscape, under the supervision of government officials, meant that patterns of straight hedges developed, forming regular, rectangular fields. Wire fences were unknown, and wooden ones were expensive, difficult to make and required frequent repair and maintenance. A planted hedge was a self-renewing, cheap and effective way of dividing up the open countryside into private compartments.

Changed farming The fields enclosed by these old hedgerows were of sizes appropriate to the farming procedures of past centuries. Modern ways of farming the land operate according to a different set of 'rules'. What was a convenient sized field to plough with a horse is now an inconveniently small patch in which to manoeuvre a large tractor that can pull a plough along several furrows at once. The hedges have become a nuisance, necessitating more time-consuming turns with the tractor and, of course, 'wasting' the space on which the hedge itself grows.

The result is that the landscape has undergone extensive reshaping to accommodate modern farming procedures, the main alteration being large-scale hedgerow removal. In the early 1950s there may have been over 750,000km (470,000 miles) of hedgerow in Britain, but during the last 25 years the length of hedgerow has sharply declined in many parts of the country, especially East Anglia. In counties such as Devon, where arable farming has not expanded so rapidly, the traditional kind of farming, based on stock rearing, persists and so does the extensive network of hedgerows associated with it.

Here is all that remains of a hedge after destruction by flail mower. The farmer needs to cut down only a kilometre ($\frac{5}{8}$ mile) of hedge to extend his arable land by almost half an acre.

Hedge maintenance The top illustration (see right) shows a common method of creating a hedge or repairing gaps in an old one. First, young shrubs are planted close together. After a few years the stem of each is partially cut through and the whole plant bent to one side and woven between a row of stakes driven into the ground. This forms an effective barrier, and regular trimming keeps the bushes dense.

The A-shaped hedge shown in the middle illustration provides a good wind-break for the farmer, is less liable to be damaged by a heavy fall of snow, and is easy to trim mechanically. The tapered shape allows saplings to grow into trees and so there is more shelter for wildlife, while nesting birds, small mammals and insects find good cover in its dense branches.

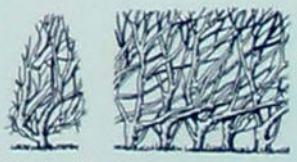
When a hedge is just cut straight across the top and sides, as in the third example, saplings are not given a chance to grow into trees, and the hedge tends to thin out at the base, leaving less cover for wildlife.

Natural sanctuary For the naturalist, the loss of hedgerows means loss of wildlife diversity and the creation of a more uniform and monotonous habitat.

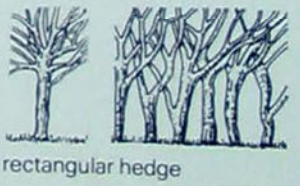
Hedges are an important refuge for wildlife in otherwise open, inhospitable arable fields. Hedgehogs are often found in a

Hedge maintenance

cut and layered hedge



tapered hedge



rectangular hedge

hedge bottom, and the mole has responded to the enlargement of field sizes by establishing itself under hedges, from whence it makes its forays into the open. Voles, field mice and shrews, including the pygmy shrew, are safely protected in the hedge undergrowth and for the insect-eating species–hedgehogs, shrews and moles–the hedge contains abundant prey.

Hedges are also 'wildlife highways', allowing plants and animals to disperse from one area to another, as described on page 18.

History of a hedge The older a hedge, the more shrub species it is likely to be composed of, having had more time to accumulate additional plants. Indeed, the age of hedgerows can be estimated from the average number of shrub species found in a 30-yard (or 90ft) length of hedge. The newest hedges usually contain hawthorn, the species favoured for rapid hedge planting in the 18th and 19th centuries because it grew fast and quickly formed a dense, thorny barrier. For every additional shrub species found, one can estimate that the hedge is probably a further 100 years old.

Hedgerows also harbour large numbers of fine trees, particularly elms and oaks, which become a feature of the landscape and also home for many species of birds and insects.

Predators and pests The farmer needs to produce crops as efficiently as he can, but there is possibly a risk that by removing hedges he could incur losses which may outweigh the gains. For example, the hedge may be an important base from which predatory beetles make their raids on aphids that cause so much damage to beans and many other crops. The birds of the hedgerow include corn and reed bunting, whitethroat, yellowhammer, song thrush, blackbird and linnet. The lesser whitethroat is most closely associated with hedges–hardly ever is its nest found anywhere else. The insect-eating habits of the hedge birds help to reduce the numbers of insect pests.

Above: Hedgerow wild flowers: purple loosestrife, meadow sweet and mint.

Below: untended hedges are attractive to birds and insects, but tend to be thinner at the base due to shading out of lower growth.

On the other hand, hedges also shelter many farm pests, notably rabbits, which make raids into the fields. The farmer may prefer not to weigh up the pros and cons of pests and their predators, but hope to do away with both together–by removing the hedge and treating the land with pesticides.

Wind barriers One beneficial role played by the hedgerows is to modify the climate around them. They act as barriers to the wind. When they are removed the wind can blow without hindrance in any direction over enormous areas. In dry winter weather this presents the farmer with the serious threat of drying out his ploughed fields, which can be harmful in the extreme. The crops have not yet grown much, so their roots do not bind the soil, nor do their leaves protect it. The wind whips up the surface layers, including seeds and costly fertilizer, and all this literally disappears over the horizon in a cloud of dust. The presence of hedges does not prevent this altogether: a hedgerow only shelters a downwind area equivalent to 20 times its own height; but as a whole, a succession of hedges will combine to slow the wind and ameliorate its effects. Thus, by sheltering fields and wildlife, they make their contribution to the countryside.

BUTTERFLIES AT RISK

Modern farming methods, the use of pesticides to kill weeds and variations in climate all affect the survival of our butterflies. We have several resident species which are threatened by extinction.

Britain is too far north, too cool, and too cloudy to support a rich variety of butterflies. Some of our 63 or so resident species are extremely local or rare and, being on the edge of their range in Britain, can only just survive. Those at risk of extinction, were all more widespread in distribution in the past than they are now.

Long-tailed fen dweller The large yellow and black swallowtail is now confined to certain parts of the Norfolk Broads. At one time it was widespread in the fens of East Anglia, and elsewhere along the Thames. It survived at Wicken Fen in Cambridgeshire until the early 1950s, but repeated attempts to re-introduce it from Norfolk have failed.

The swallowtail lays its eggs on milk parsley, a fen plant. Although the caterpillars feed on a variety of related plants, including the leaves of carrots, milk parsley seems to be their only natural food plant in Britain. When irritated, the caterpillar extends a strong-smelling, V-shaped structure that is situated behind its head. This organ is characteristic of the family Papilionidae.

British swallowtails are more heavily marked with black than Continental ones, and are altogether more particular in their requirements. On the Continent swallowtails are found in open country, not just in fens, and the caterpillars feed on half a dozen or more food plants. Our swallowtail, although restricted to the fens around the

Above: The magnificent swallowtail butterfly – it is the only representative in Britain of the family Papilionidae, and is confined to certain places on the Norfolk Broads. This species is our largest resident butterfly. The mature swallowtail caterpillars can be recognised easily by their bright green colour and striking black and orange markings.

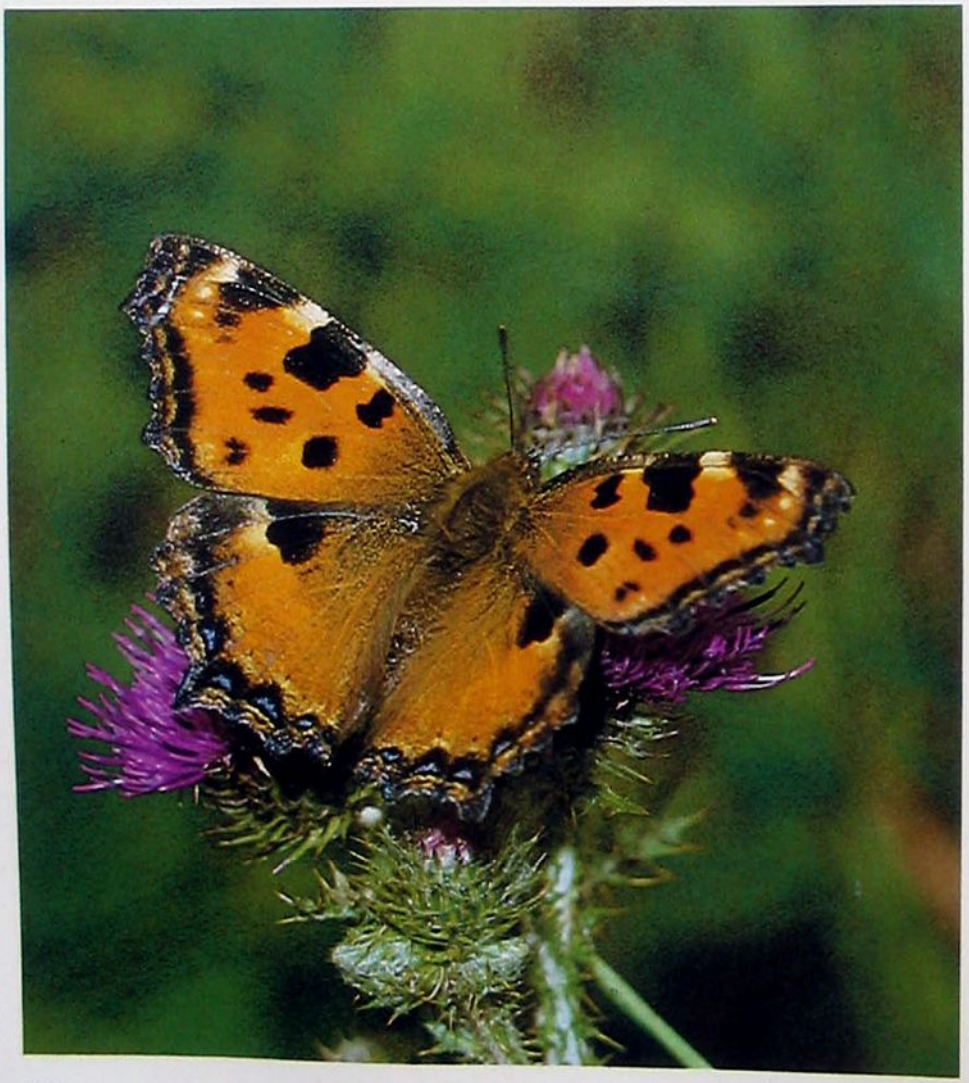
Climate or cultivation?

Modern methods of agriculture and forestry, especially the intensive use of chemical pesticides and weed-killers, are undoubtedly a threat to resident butterflies, and many species have declined in numbers in the last 30 years. All the blame, however, cannot be put on agriculture and forestry. The glorious summer of 1976 resulted in a profusion of butterflies, the like of which has not been seen for many years. Common species were even more common than usual and rare residents turned up in unexpected places, confirming what butterfly-watchers had suspected: good butterfly years are associated with fine summers, no matter what the previous winter was like, or what the farmers had done to the countryside. Evidently, if climatic conditions are right, butterfly populations can increase dramatically. In fact, the events of the summer of 1976 raised doubts as to whether many resident butterflies had really declined or whether they had survived in such low numbers that they had been overlooked.

Norfolk Broads, should survive provided its food plant is not allowed to become overgrown and shaded out by dense growths of sallows. The real problem for the swallowtail is that it lacks space: the Broads, nature reserves though they are, are rather small in area and some of the butterflies' haunts, being surrounded by farmland, are in danger of drying out.

The adult butterfly is out and about in May and June, and there is often a partial second brood in August, especially if the weather is good. Winter is passed in the pupal stage and the pupae, sometimes brown but usually green, are attached by a silk girdle to leaves.

Below: Large tortoiseshell butterfly. It closely resembles the abundant small tortoiseshell but is more orange in colour and lacks the bright bluish spots along the outer edge of the forewings. The food plants of the large tortoiseshell caterpillar include willow, sallow, aspen, poplar, cherry and nettle.



also has specialised requirements in E
yet it is found in a wide range of habi
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uncommon on parts of the Kent coas
brownish-orange, black-speckled butt
now confined to parts of the south c
the Isle of Wight, where it can be abun
places. Various attempts to introduc
the mainland have met with limited su

The Glanville fritillary frequents ex
of fallen cliffs that are in the process o
colonized by grasses and herbaceous
including sea and ribwort plantains, t
plants of the caterpillars. As time pass
the vegetation grows and becomes
shrubby, the habitat becomes less s
and eventually the butterflies dis
However, since the cliffs are co
eroding away, new areas are con
created. The Glanville fritillary thus
shift around within its restricted distri
and its survival is assured so long
Isle of Wight cliffs continue to crum
the sea.

Glanville fritillary caterpillars are
and easy to find in great clusters wh
emerge from hibernation in sprin
love the sun and, if the weather is
and cool, remain motionless for long
without feeding. Their black co
enables them to absorb radiant e
bright sunshine even when the a
temperature is low, and it might be
south-facing slopes of fallen cliffs
only places in Britain where there is s
spring sunshine for the caterpillars to
The caterpillars hibernate when l
full grown in a communal web. Th
fly in late May and June.

Copper-coloured survivor The b
coloured large copper butterfly is no
only at Woodwalton Fen National
Reserve in Cambridgeshire. Even h
not a true resident. The British for
butterfly, slightly larger and brig
colour than the various Continenta
used to occur in a number of fens
bridgeshire and Huntingdonshire,
came extinct in 1851, probably as a

Large copper *(Lycaena dispar)* adult, caterpillar and egg. Wingspan is 3.5-4cm ($1\frac{1}{3}$-$1\frac{1}{2}$in)

draining and the conversion of the fens to productive arable land. It was also popular among the 19th century butterfly collectors and dealers and this, too, may have contributed to its downfall. Several unsuccessful attempts to introduce Continental large coppers to suitable fenland habitats were made earlier this century, but it was not until 1927 that there was a properly planned introduction to Woodwalton. Dutch butterflies were used because they were considered to be closest in appearance to the extinct British form.

The female large copper lays her eggs in August on great water dock, a semi-aquatic plant, and the young slug-like caterpillars nibble the leaves before entering hibernation. In spring the caterpillars reappear, but numbers vary from year to year for, although they can survive under water for some time, some are killed by winter floods. Some caterpillars of the Dutch race have been found to survive continuous submersion for as long as 11 weeks.

Before the 1927 introduction, parts of Woodwalton Fen were specially prepared: shrubby vegetation was cleared and a plentiful supply of great water dock was planted. The introduction was a success and the butterfly has survived, albeit precariously. The large copper is common in some years (1976 for example) and scarce in others. In the summer of 1968 the Fen was flooded and most of the food plant submerged, and by 1969 it became apparent that the butterfly was once again extinct. Accordingly, in 1970 it was re-introduced from captive stock and still survives today, but only by careful management of the food plant and by regulating water levels can its future be assured.

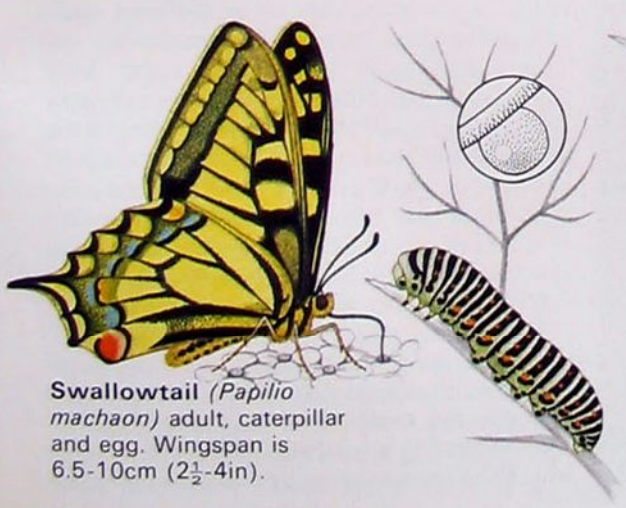
Resident or non-resident? The large tortoiseshell, a large, brownish-orange butterfly with black markings, is something of an enigma so far as its status in Britain is concerned. At one time or another it has been found throughout England and Wales, and even southern Scotland, but since 1950 it has declined dramatically and is now rarely seen. Oddly enough, there have never been localities where the butterflies can be relied on to occur.

The normal food plant of the caterpillars is elm, which in the south may be difficult to find today because of the virtual disappearance of the trees due to Dutch elm disease. However, the decline of the large tortoiseshell occurred too early for Dutch elm disease to be blamed, and, in any case, it has other food plants.

One possibility is that the butterfly is an immigrant from the Continent, and from time to time establishes itself for a few years in a particular locality. The species has decreased in parts of western Europe, which may mean that fewer immigrants could be expected here. Whatever the explanation, if you see a large tortoiseshell you should report the event to your local natural history society or naturalists' trust. The adult butterflies emerge in July and August, but they quickly go into hibernation. They are more often seen after hibernation in spring. They are just as likely to appear in a garden as in the countryside.

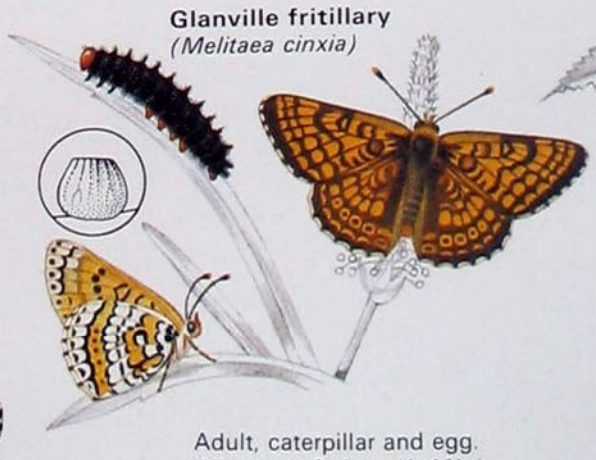
Above: Two pupae of the large tortoiseshell butterfly. The adult emerges from the pupa in early July and overwinters in this form.

Below: **Large tortoiseshell** *(Nymphalis polychloros)* adult, caterpillar and egg. The adult's wingspan is about 5-6cm (2-2½in).



Swallowtail *(Papilio machaon)* adult, caterpillar and egg. Wingspan is 6.5-10cm (2½-4in).

Glanville fritillary *(Melitaea cinxia)*



Adult, caterpillar and egg. Wingspan 3-4cm (1-1½in).

FISH: THE FIVE SENSES

The sensory organs of a fish equip it superbly for survival – good vision, an excellent sense of smell, hearing, and pressure detectors all help it find food, avoid predators and recognise its own kind.

Because fishes live in water, a medium alien to man, people find it difficult to judge how well a fish's senses work. In contrast with, say, a bird like a chaffinch, which we know from everyday experience can sing and thus hear, as well as see, our appreciation of a fish's senses is almost non-existent. We cannot hear them make noises, and therefore cannot assume that they are able to hear, nor can we easily prove that they see well, or that they see in colour. It is also difficult to guess how sensitive they are to flavours.

However, scientific examination of fish sense organs shows that fish are well-equipped to cope in their watery habitat; indeed, the sensitivity of some organs is far greater than that of many other animals.

Looking through lidless eyes One of the noticeable features of a fish is its eyes – large, bulging, dead-looking organs that lack the eyelids of mammals.

The anatomy of a fish's eye is basically the same as in all other back-boned animals: it is spherical, with a tough, protective outer cover in the front; there is a hard, crystalline lens surrounded by an iris; and at the back of the eyeball there is the retina, layers of light-sensitive cells with rich blood and nerve supplies. The lens of a fish's eye is a perfect sphere (a human eye lens is oval in cross-section); it is also absolutely clear and positioned close to the outer covering of the eye. Images of the fish's surroundings are transmitted, without distortion, on to the retina. In general, the fish can see for a considerable distance without difficulty, but if it needs to see some close object clearly, then special muscles move the lens within the eye to attain perfect focus.

Most of our freshwater fishes, such as the carp (above), are thought to be able to distinguish colours. The two pairs of nostrils you can see on each side of the carp's head are not concerned with breathing but with the linked senses of taste and smell.

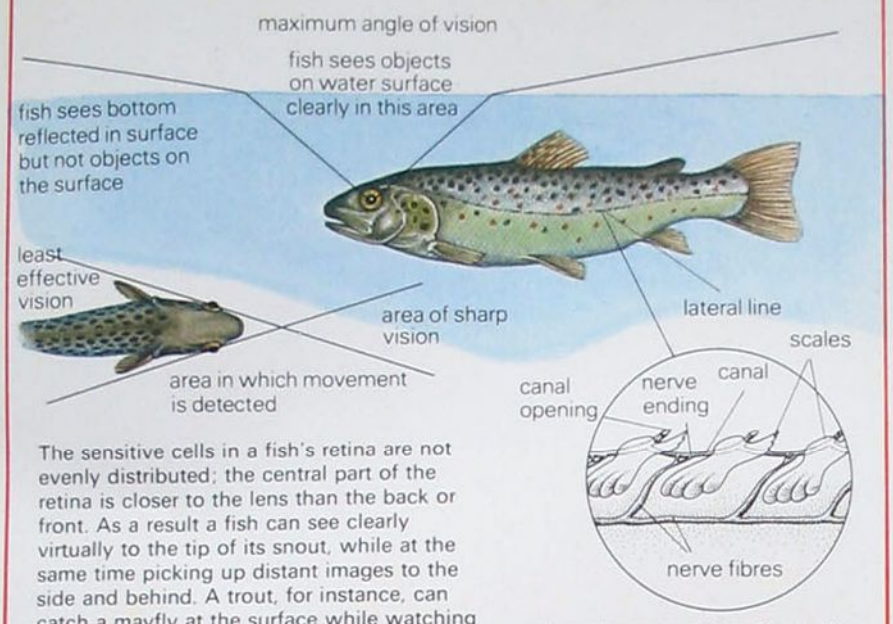
The stone loach (below) is well equipped with sensory barbels which it uses to find food. It stays close to the bottom of rivers and brooks and is mainly nocturnal.

Many of the individual cells that make up the retina are of the type known as cones; they are sensitive to bright illumination and colour and there is every reason to believe that most fishes can distinguish colours well. This is not true of deep-sea fishes, or ones that are most active at night or live habitually in murky waters.

Smell and taste link-up The senses of smell and taste in fishes are interlinked. Fishes have two pairs of nostrils on each side of the head, but they have nothing to do with breathing as in mammals; they lead to two chambers (nasal sacs) one on each side of the head, each of which is filled with sensitive sensory organs. In fishes that rely heavily on their sense of smell – the eel, for instance – these organs are very elaborate. Eels can detect one thousandth of a gram of crushed worm in 267 million litres of water (about 58 million gallons).

The organs that give fishes their sense of taste are specially enlarged cells scattered in the mouth, on the lips, on the barbels, and even on the lower head and pelvic fins of some fishes. A carp tastes its food by touching it with its barbels or its lips – it does not need

Sight and pressure senses in fish


maximum angle of vision
fish sees objects on water surface clearly in this area
fish sees bottom reflected in surface but not objects on the surface
least effective vision
area of sharp vision
lateral line
scales
area in which movement is detected
canal opening
nerve ending
canal
nerve fibres
enlarged cross section of lateral line

The sensitive cells in a fish's retina are not evenly distributed; the central part of the retina is closer to the lens than the back or front. As a result a fish can see clearly virtually to the tip of its snout, while at the same time picking up distant images to the side and behind. A trout, for instance, can catch a mayfly at the surface while watching a pike lurking to one side.

to take the food into its mouth to find out if it is edible.

The sense of taste plays a large part in finding food. If you watch a pouting or a cod in an aquarium you can see them swimming close to the bottom with their chin barbels and long pelvic fins brushing the sand and constantly searching for food.

Grunt 'n' groaners Many fishes make sounds, using a variety of methods. For instance, the herring blows bubbles from its swim bladder, other fishes grind their teeth or, like the cod, haddock and the gurnards, grunt and groan using their swim bladders to amplify the noises made by special muscles.

Life in the sea is, in fact, far from the 'silent world' of popular belief. Fishes of the carp family have a distinctive bony connection between the swim bladder and the inner ear which probably helps them to hear more acutely. It is also fairly certain that a large roach crunching up pond snails with its throat teeth makes a noise that can be easily heard in the immediate vicinity by other fishes, particularly by other roach. Schooling fish, such as herring or sprats, are surrounded by a 'noise shadow' as they swim; this 'shadow' is caused by the movement of hundreds of beating fins and flexing muscles. The more advanced noise-makers, such as the haddock, grumble and drum as they move around in a school on the sea bed. The advantages of fishes making noises, and being able to hear well, are that a school can keep together – even when they cannot see one another in the sunless sea. The fishes in the school also communicate about potential food or predators in their surroundings.

Pressure detector The lateral line, which is seen in most fish as a line of pores opening on to the scales on the side of the body, is another fish sensory system difficult for man to understand since we totally lack such a sophisticated sense.

What we see as a line on the fish's side is actually a canal with openings along its length; within the canal are special sensory cells that can detect changes in pressure. As a fish swims beside its fellows in a school, the changes in water pressure caused by the flexing bodies are detected by these cells. Then, as the school nears an obstruction in the river bed, the pressure waves are deformed; this change is detected, as also are the changes in pressure caused by an attacking predator. The effect must be something similar to a continuously registering radar system, alerting the fish to movements of many kinds in its immediate surroundings.

Sensitivity to electricity Sense organs that can detect the minute electrical charges of living muscle are a feature of some fishes, notably skates and many sharks. These fishes are known to have a system of pores particularly on their undersides which can detect minute electrical charges. The skates certainly produce their own electrical fields, and probably use them to recognise individuals of their own species on the sea bed. These modest electrical abilities are developed to an extreme in the electric ray (an uncommon British sea fish) which uses its powerful electric current – up to 220 volts at 8 amps in a big fish – to stun prey.

Below: The pike, a fish that relies mainly on its good eyesight to catch its prey, has relatively simple sense organs in its nasal cavity. By contrast, the eel has an exceptionally well-developed sense of smell.

LOOK-OUT FOR BIRDS!

We do not know exactly how birds navigate with such precision, but we can learn a lot about their comings and goings from the information gathered at the 14 observatories around the British Isles.

Bird migration has been an accepted natural phenomenon since man first put pen to paper, fascinating the ancients as much as it intrigues us today. Some of the earliest references to migration occur in the Old Testament of the Bible, for example in the Song of Solomon:

For lo, the winter is past, the rain is over and gone

The flowers appear on the earth; the time of the singing of birds is come, and the voice of the turtle is heard in our land.

The turtle referred to is not of course the voiceless marine reptile, but the turtle dove.

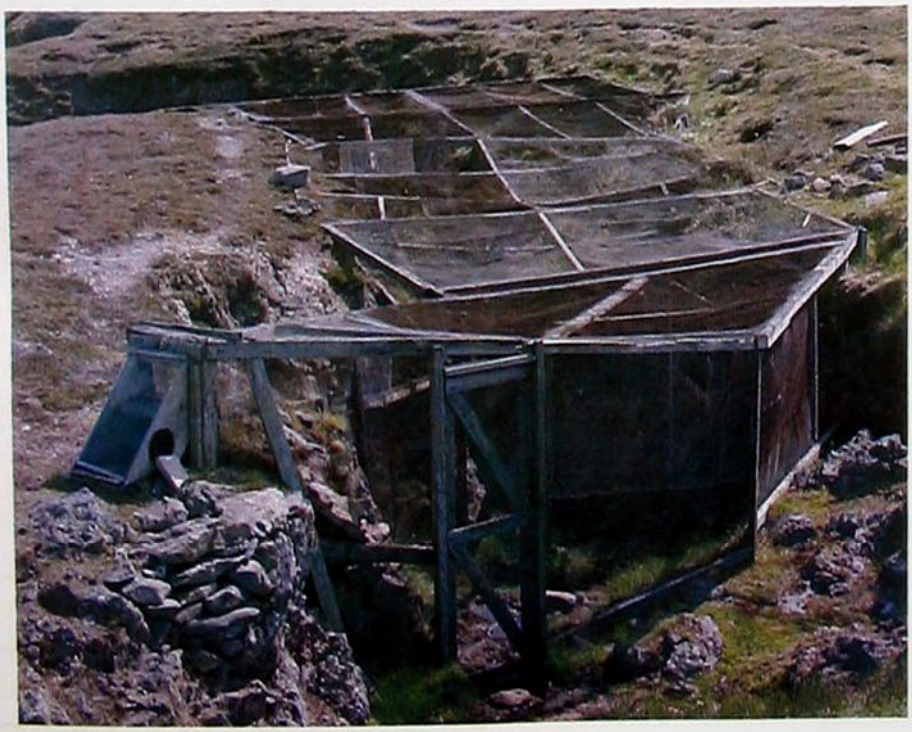
As man became more scientifically interested in his surroundings, dispute raged as to how the migrants navigated, and where they went in winter. As recently as 200 years ago people thought swallows and martins overwintered in the mud at the bottom of ponds. However, bird ringing and the work of an international network of bird observatories has helped to show where the birds go, revealing not only their wintering areas, but also giving much information on the long and hazardous journeys that most migrants undertake. But how migrants navigate with an accuracy that puts man's modern navigational aids to shame, remains an unanswered question, even in this technological age, and seems likely to remain one of the greatest unsolved natural mysteries for many years to come.

There are a few places where migration is so obvious that no one could fail to notice what was going on. An excellent example is the concentration of tens of thousands of birds of prey and storks crossing the narrow waters of the Bosphorus, en route between Europe and Asia and Africa. The information gathered in such areas was the inspiration behind other early migration observations points established in the early years of this century, and manned by a few enthusiastic pioneers. These observation points were coordinated by the British Association for the Advancement of Science, and they were usually situated on islands, headlands, isolated lighthouses and lightships that seemed

Above: The observatory at Fair Isle in the Shetlands which sees an astonishingly large percentage of rarities from as far afield as North America and the Far East, and offers an experience rarely to be obtained elsewhere.

Right: A Heligoland trap at the Fair Isle Observatory. Such traps are derived from the traditional bird-catching methods on the remote island of Heligoland, and they have been used for the last 30 years. This trap is built in a gully; others may be located over areas with bushes where the birds gather naturally. Most heligolands are about 3.5m (10ft) high and up to 17m (55ft) wide at the entrance.

Above: A kestrel being ringed. Each ring carries an individual number and an address in case of recovery. Details are logged of the species, the place and date, together with several useful vital statistics such as measurements and details of the ringed bird's age and sex.



to lie on natural north-south flyways. Modern bird observatories are located in similar places.

The first bird observatory proper was founded by one such enthusiastic amateur, Heinrich Gatke, who spent 50 years in the latter half of the 19th century on the then British (now German) island of Heligoland, off the German North Sea coast. His account of migration through the island, *Die Vogelwarte Helgoland*, makes compelling reading even today, and although some of the birds he mentions are now rare, the pattern of events is much the same.

Island observatories Islands have several advantages as bird observatories. They often have a lighthouse which may attract night migrants, especially if the weather deteriorates overnight. This landfall may be salvation for the many birds you can see in bushes on islands at daybreak, but unfortunately many birds are killed as they fly, dazzled, into the lantern or tower. As islands are of a limited size and often have relatively few patches of suitable vegetation to shelter migrants, the birds can be counted easily and a pattern of occurrance associated with the time of year and weather gradually built up.

The first British observatory was founded in 1933, on the Welsh island of Skokholm off Pembrokeshire, by Ronald Lockley whose family were the only inhabitants and farmed the island. Today the island is no longer farmed and ringing is no longer carried out there, but it is still an observation point.

Since 1933 the network around the British and Irish coasts has grown and now 14 observatories are represented on the Bird Observatories Council. They are augmented by several informal ringing stations. Many island observatories are difficult to reach because of their remoteness, but others

such as Portland Bill in Dorset, Dungeness in Kent and Gibraltar Point in Lincolnshire, are within easy reach.

What does an observatory do? In most cases the observatory area is carefully scanned to note arrivals, and a daily log is kept of migrant numbers and the direction of their movements. This can be exciting work – sometimes because of the sheer number of birds arriving or passing over (for example, the autumn 'fall' of thrushes on the east coast), or perhaps because a rarity from afar has appeared, blown off-course. Located on islands or the tips of peninsulas, they must appear to migrant birds much as an oasis does to a desert traveller.

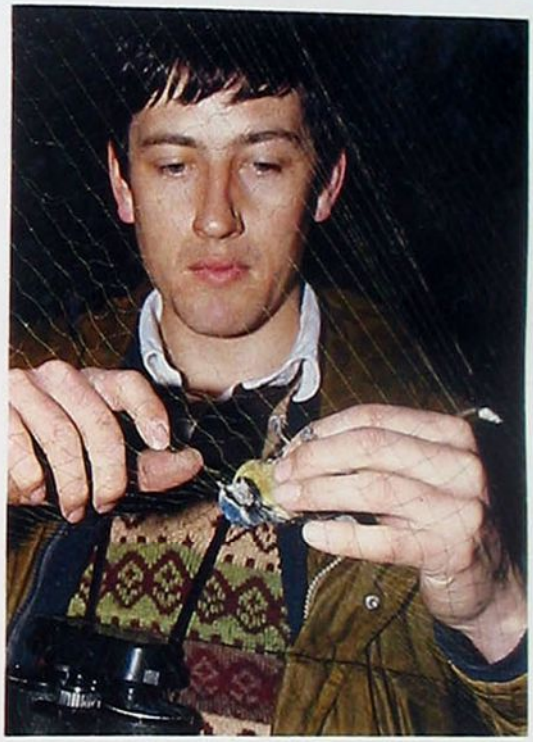
Most observatories operate ringing programmes, some using nets and some large, permanent walk-in funnel-shaped traps built of wire netting over a line of bushes. These are known as Heligolands, after the first, very effective, design built by Gatke on that island.

The migration season runs from March to November, with only a brief midsummer lull, so there is much to be seen. In addition, some observatories have breeding seabird colonies, and others, like Dungeness, are so situated that migratory movements of seabirds such as skuas, terns and divers, pass by close inshore, offering good views of species that are notoriously difficult to see well.

Although the birds seen and ringed are only a small proportion of the vast migratory movements – some birds fly only at night, for example, and others are usually far too high to be seen – the facts and figures produced by the concerted efforts of the bird observatories have helped enormously in our understanding of bird migrations. Much has been learned about the routes birds follow and where their final destinations lie. With the help of bird observatories scientists are beginning to understand the great mystery of bird navigation. For example, it is now known that migrations are hindered by fog and heavy cloud, which implies that the sun and stars are important aids to navigation.

All this requires much patient observation, with visiting bird watchers playing an important role in helping the resident warden in his work. Details of our bird observatories and how to visit them are available from the British Trust for Ornithology.

Above: A blackbird having its wing measured.

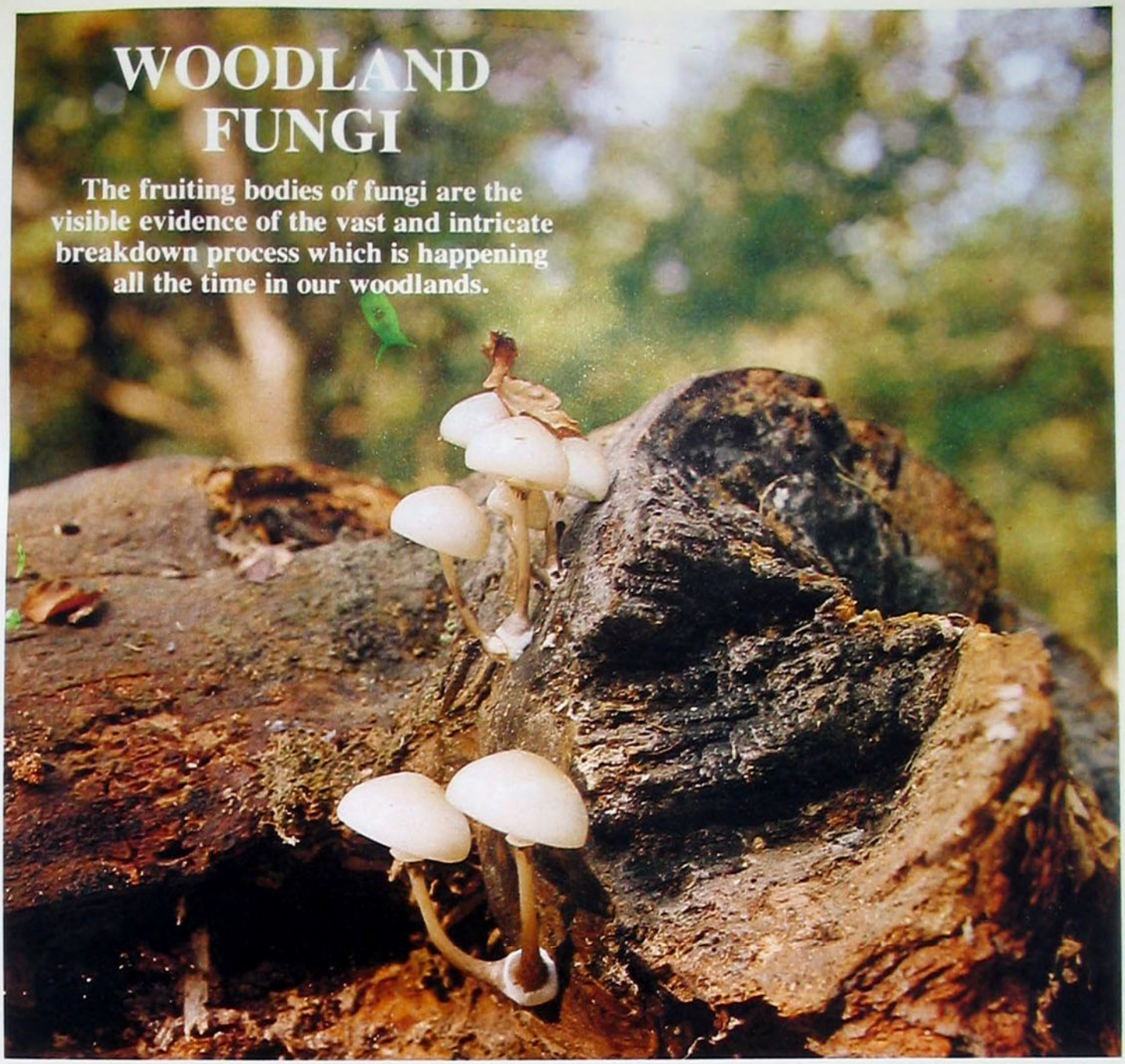


Right: A blue tit being extracted from a mist net – a very fine netting which catches birds in flight.

Below: Observatories record sightings of rare visitors from Europe, such as this bluethroat.

WOODLAND FUNGI

The fruiting bodies of fungi are the visible evidence of the vast and intricate breakdown process which is happening all the time in our woodlands.



Fungi not only appear on living trees as parasites, they are also active on dead and decaying matter as saprophytes, most of them playing an important part in the breakdown of organic matter.

Whereas green plants build up complex food substances from simple ones, using energy from the sun, fungi do the opposite. They have to take their sustenance from living and dead plants, since they lack the chlorophyll necessary to manufacture their own food. Therefore, they break down complex substances into simple ones on which they can feed and grow.

There are several hundred wood-inhabiting fungi in Britain and most of them are remarkably selective in the conditions they demand for survival. Some need wet or even soggy conditions while some prefer the relative dryness of standing trees. Generally, they need damp conditions in order to produce their fruit bodies and wet woodlands provide the ideal setting. Most are host specific, that is they infect only one species or group of species.

Infecting trees Infection of wood by fungi can take place in two ways. Standing trees are infected by spores that land on them and, in damp conditions, start to grow. They send out threads known as hyphae, which form a fine cobweb-like net – a mycelium – that penetrates the wood. Secondly, trees that have fallen down or are cut down are infected by the mycelium that is everywhere on the forest floor, living on the large amount of dead material – leaves, twigs and branches – which fall from the trees.

At certain times of the year the mycelium produces a fruit body – the mushroom or toadstool that we see. This fruit body distributes spores that land and develop into a new mycelium, starting the whole process

Above: The beech tuft *(Oudemansiella mucida)* is a white fungus with a rather translucent appearance due to its coating of slimy fluid. Such an appearance gives rise to the other names by which it is known – the porcelain fungus or poached egg fungus. On standing beech trees, it generally appears fairly high up the trunks and on the branches.

over again.

Penetrating the wood Once the tissues of the wood have been entered the mycelium often grows down the phloem and xylem, the sap and water conducting channels. Some fungi live off the food stored by the tree in its sap wood, while others actually absorb the substance of the wood, producing a condition known as heart rot.

An entire tree trunk can be full of mycelium, usually of one species, although some fungi extract all they can from the wood, leaving another to follow on and break it down further. One such example is the white, pear-shaped, stump puffball (*Lycoperdon pyriforme*) which attacks wood that has been broken down by other fungi such as the dark brown deer toadstool (*Pluteus cervinus*).

Fruiting times In general, the mushrooms and toadstools that grow in grassland fruit in late summer or autumn–earlier in the north and later in the south. Those that grow on wood tend to fruit later although there are exceptions. Autumn and early winter are good times to see interesting and attractive specimens in deciduous woodland.

Above: Velvet shank *(Flammulina velutipes)* often persists through the winter to the spring when conditions are mild; it has been known to tolerate freezing temperatures. It has a tough, elastic flesh and a slimy appearance. The velvety texture of the stem gives it its name.

Left: The striking stag's horn fungus has a jelly-like texture and favours wet conditions, shrinking and losing colour in dry air.

Below: *Lycogala epidendrum*, a slime fungus, has a rather unpleasant appearance. It is usually found in autumn on dead wood and may vary in colour from pink to pale yellowish-brown.

Bracket fungi Species to look out for include the aptly named beefsteak fungus (*Fistulina hepatica*), which has a dark red, sticky upper surface and oozes a red juice when cut. It usually grows on oak, causing the wood to develop a deep, rich colour, which makes it very popular with cabinet makers. Oyster mushroom (*Pleurotus ostreatus*), has widely spaced gills on its underside and a grey-brown cap. It grows mainly on beeches, attached by the stalk that appears on its side. The razor strop fungus (*Piptoporus betulinus*) has a smooth, greyish skin which develops a corky texture with age. It is widespread on dead birch trees in the south of the British Isles, while its place is taken in the north of Scotland by the hoof-shaped tinder fungus (*Fomes fomentarius*), which causes white rot in the trees which it infects.

Hardly any deciduous wood lies on the ground for long without producing a crop of the banded bracket fungus (*Coriolus versicolor*), which has a velvety upper surface, banded with shades of yellow, brown and grey. Appearing at ground level, growing from the wood of the roots of beech tree stumps, is a remarkably large fan-shaped bracket fungus, *Meripilus giganteus*, which can measure up to 80cm (33in) across. It often grows in tiers, forming very large and conspicuous colonies.

Toadstools *Pholiota* is a genus of yellow fungi with varying degrees of scaliness of the cap and stem, and is particularly common on dead beech trees, while charcoal pholiota (*Pholiota carbonaria*) grows in large numbers on burnt ground. These species are often confused with the beautiful golden *Gymnopilus junonius*, which is distinguished by the marked ring on its often swollen stem. It is

generally found growing in dense clusters at ground level.

When the wood has been broken down into pulp or sawdust, some of the cup fungi, such as the wavy-edged *Peziza repanda* start to grow, the fruit bodies appearing in the autumn. If it is wet enough a remarkable species, *Lycogala epidendrum*, may appear. It is a slime fungus, which is capable of spreading out into a thin layer until it is ready to fruit. The thin film then actually moves until it has gathered itself into pink balls about 1cm ($\frac{2}{5}$in) across which harden, turn brown and break down to reveal a powdery mass of spores in the centre.

Elms killed by elm-bark disease are subsequently broken down by the autumn fruiting *Lyophyllum ulmarium* or by the velvet shank (*Flammulina velutipes*).

Conifer tree fungi Coniferous woodlands tend to have a smaller number of bracket fungi than deciduous woodland but they make up for it in the beauty of those fungi that do appear. Among these is the orangey brown *Phaeolus schweinitzii* which has an upper surface covered with stiff hairs. It attacks pine in particular, breaking the wood up into small cubes. The small but attractive short, forked stems of the stag's horn fungus (*Calocera viscosa*) are common on the sawn-off stumps left by the foresters' thinning operations, and this fungus is, therefore, much less common in natural woodland.

Foresters dislike the honey fungus *(Armillaria mellea)* because it attacks living trees, spreading to them by long cords known as bootlaces (above), which may be found under the bark of infected trees causing extensive rot.

Stump puffball *(Lycoperdon pyriforme)*, summer to late autumn in groups on rotten logs. Up to 5cm (2in) tall.

Phaeolus schweinitzii, found in autumn on conifers, usually near the roots. Can reach up to 30cm (12in) across.

Oyster mushroom *(Pleurotus ostreatus)*, common all year in groups on standing and fallen trees. Up to 14cm ($5\frac{1}{2}$in) across.

Gymnopilus junonius, common late summer, early winter in groups at base of deciduous trees, logs, stumps. Up to 15cm (6in) across.

Peziza repanda found spring to autumn around stumps of trees or on sawdust. Up to 12cm ($4\frac{3}{4}$in) across.

Beefsteak fungus *(Fistulina hepatica)*, common late summer, autumn on lower trunk of oak and chestnut. To 25cm (10in) across.

Banded bracket fungus *(Coriolus versicolor)* common all year on dead deciduous trees. Up to 10cm (4in) across.

OTTERS IN A SCOTTISH WINTER

The hardiness of the otter is legendary; even in winter it sleeps in couches open to the elements, curled up in soggy piles of vegetation. Sometimes cubs are born in winter as well.

The Scottish Highlands are one of the last strongholds of the otter in the British Isles. But midwinter among the moors and mountains is a hazardous time for all wildlife. Snow blankets mountain and glen alike; ice sheaths the creepers and other vegetation hanging in the still-trickling rivers; the lochs are usually icebound; and the temperature remains almost constantly below freezing point. Many animals (such as frogs and toads) hibernate, and many birds migrate to warmer climates or move to more clement parts of the British Isles, but the hardy otter usually remains to confront the freezing, snowy conditions of winter, only moving to warmer coastal sites in times of extreme hardship.

Food shortages Diminished food supplies are a major hardship for the otter in winter. Favoured prey such as frogs, eels and freshwater crayfish retreat into deep mud or inaccessible crevices to overwinter in a state of inactivity, and shoaling fish commonly move into deep water where they are less vulnerable to cold; as a result the otter has difficulty reaching them. Mammals such as voles, and waterfowl, which the otter eats on occasion, die in the severe winter conditions, or are lessened in numbers by migration. In areas of Scotland that are remote from the sea the food sources are much reduced in quality and quantity. Then the otter must subsist on carrion, feeding on crows, rats and other animals that have been dead for some time. During the bad winter of 1979 red deer that had died of starvation in a remote area of Sutherland were eaten by many starving animals, including otters.

In some areas, salmon and trout move to shallow winter spawning grounds, becoming a fairly rich source of food for any otters in the area. Large fish, however, are not normally caught. Researchers have found that a large salmon or trout is a rare meal; the remains of prey present in the otter's spraint (droppings) consist mainly of small fish.

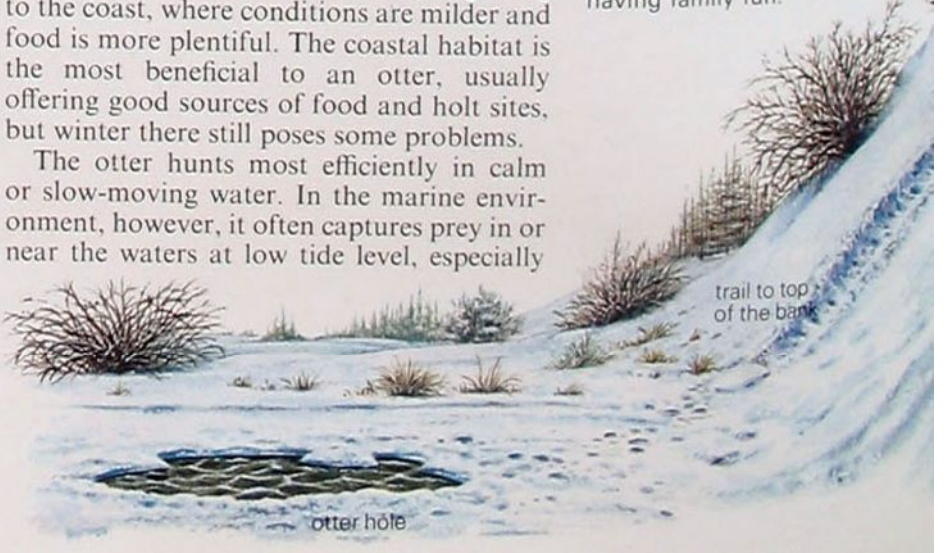
Coping with frozen waters When ice is widespread, otters break through it to enter the water beneath, producing holes about one metre long by half a metre wide (40in × 20in). As many as 37 holes have been found in a 100 metre (110yd) stretch of ice. Like some seals, otters display remarkable precision in relocating these holes from underwater. Should the freeze last some time, making the ice too thick to break, otters may be forced to crowd temporarily into areas of naturally open water, such as that found at a lake outflow. There is one sad account from Wales of an otter being trapped by its tail–it had become ice-bound in a freezing river. Although rescued, the animal died within a few hours.

Above: Winter foraging. At this time of the year, with many rivers frozen, the otters often make a fishing-hole into which they can dive and hunt fish. Sometimes they are forced to scavenge rather than hunt.

Below: In the remote, little disturbed places where they live, otters still find time to engage in play, despite the hardships of winter survival. They have been observed sliding down snowy banks having family fun.

Coastal migration In some areas the otter avoids the worst effects of winter by migrating to the coast, where conditions are milder and food is more plentiful. The coastal habitat is the most beneficial to an otter, usually offering good sources of food and holt sites, but winter there still poses some problems.

The otter hunts most efficiently in calm or slow-moving water. In the marine environment, however, it often captures prey in or near the waters at low tide level, especially



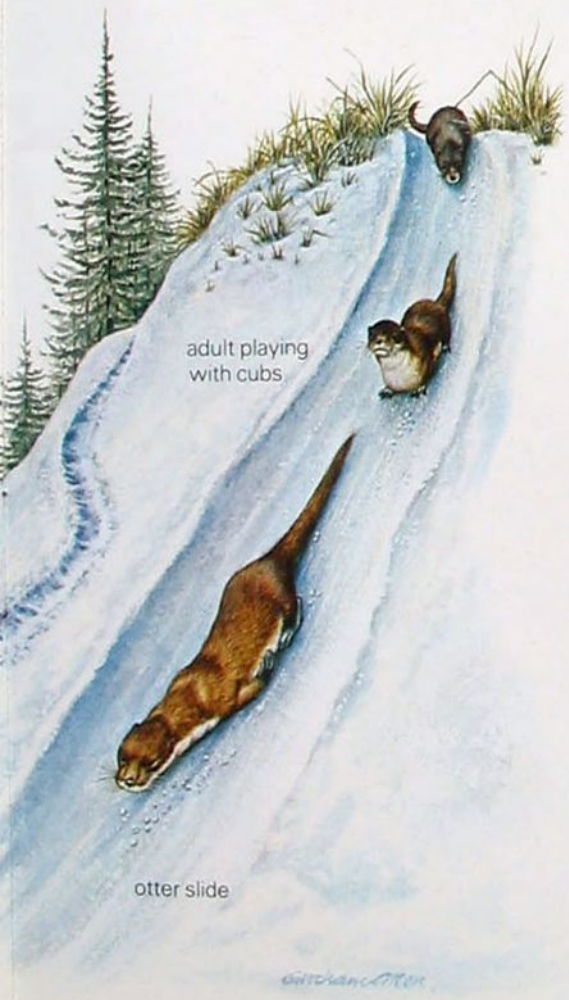
where great kelp beds are found. Winter storms and huge waves continuously breaking on the shores sometimes make hunting very difficult, or even prevent it altogether. When calmer weather returns, a hungry otter takes many risks to obtain food. After a violent, two-day storm, researchers observed one otter scavenging all morning (it is usually a nocturnal forager), clearing a stretch of shore of shrimps, prawns and fish washed up by the waves.

Inland storms are another common winter hazard with which the otter has to contend. These storms may increase the normal volume of a river by three or four times, so that it becomes a flood-river (called a spate), with enormously increased power. Overhanging trees that form favourable holt sites for the otter are often uprooted. At this time the rivers flow faster than an otter can swim, making large stretches unsafe for hunting.

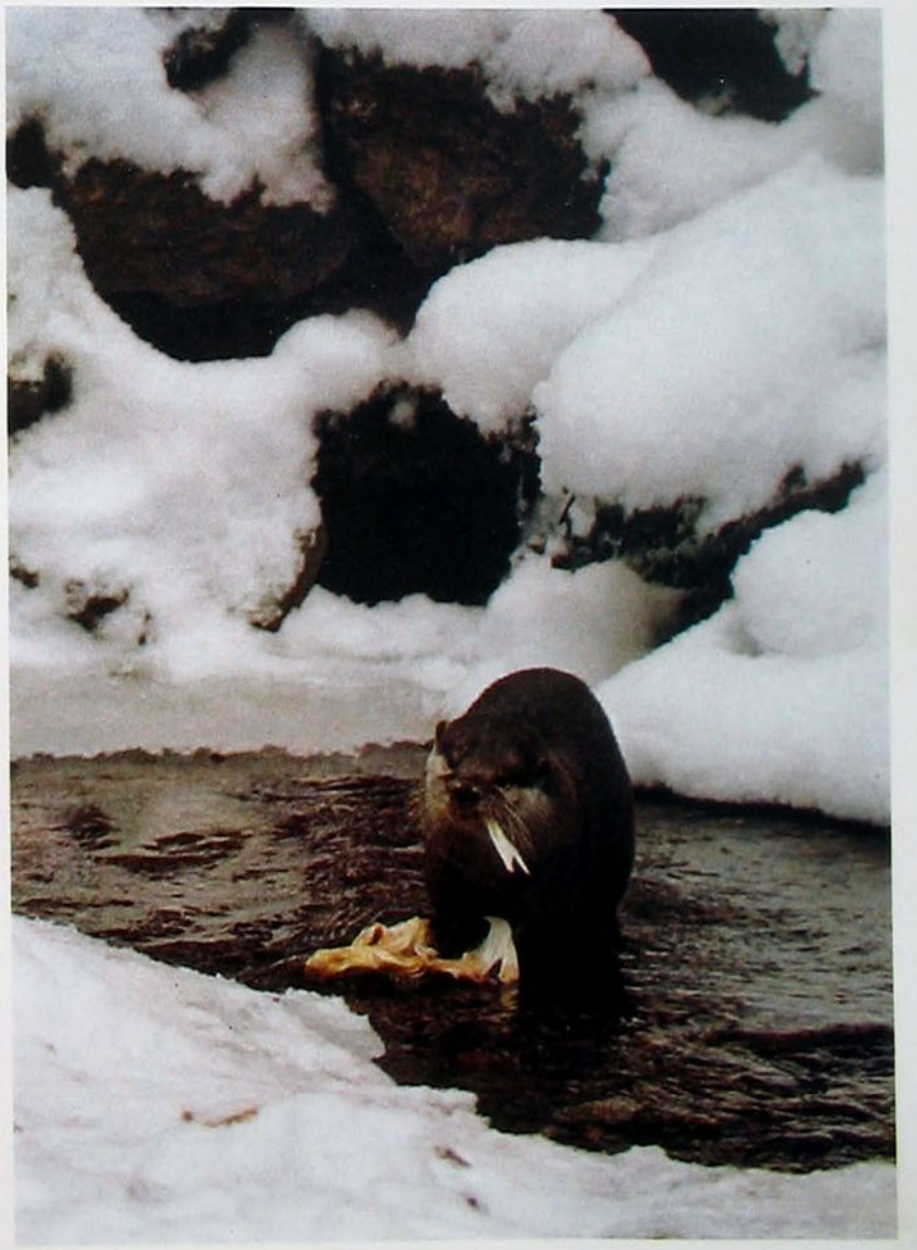
Downriver, current speeds are slower, but during spates the muddy and silty waters impede the otter's search for food (it hunts mainly by sight). Even a little light enables the otter to glimpse a fish's shiny scales, but in total darkness the otter uses its long sensitive whiskers to 'feel out' any prey, and so still manages to find some food.

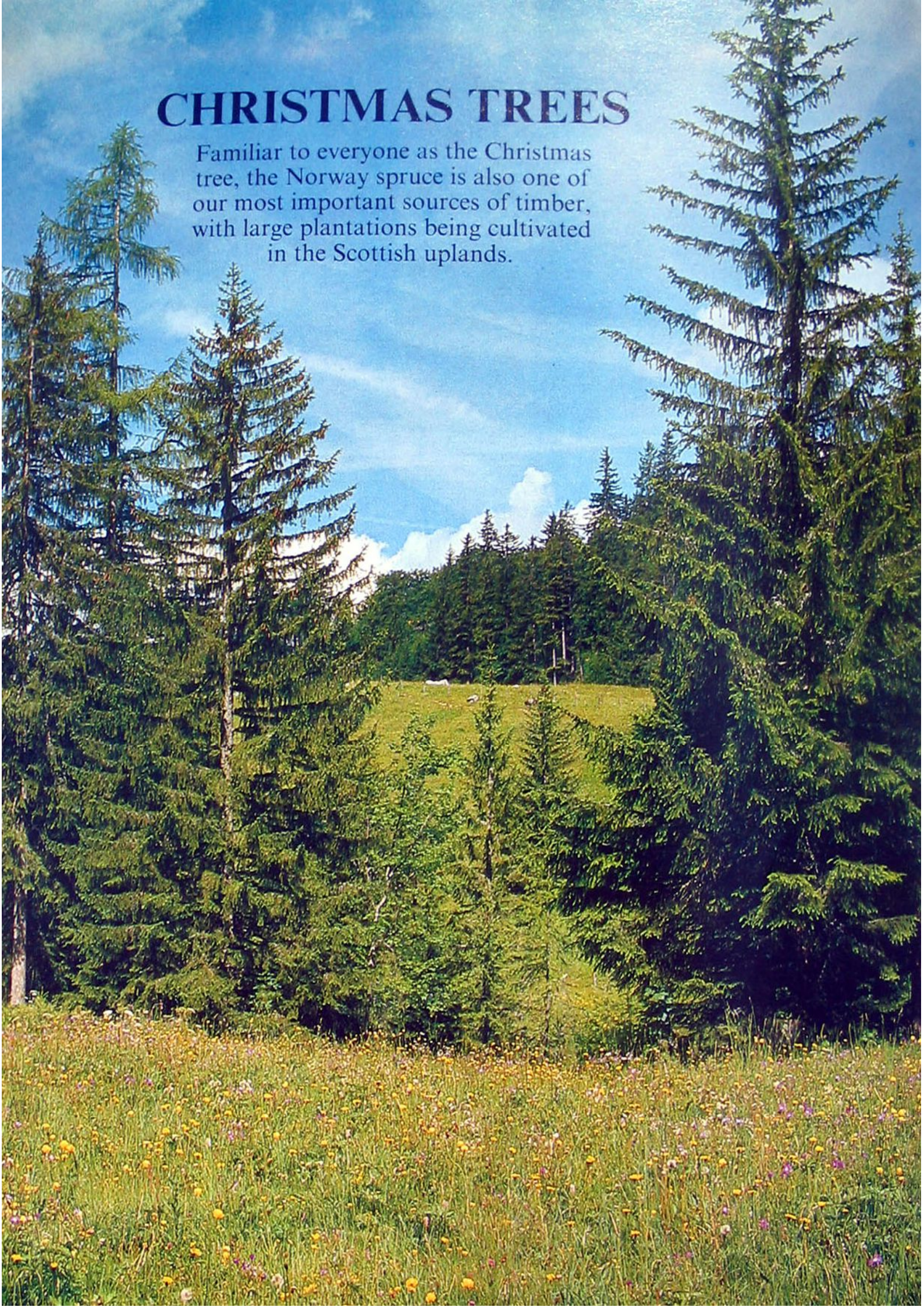
Competition with feral mink is probably something most otters face at some time during their lives. The number of feral mink has increased dramatically in the last 25 years. How much the two carnivores compete is not known, but as they feed on the same animals – up to 70% of their prey is common to both species – it would seem likely that there is some competition. However, until further research is done in the field, the subject is still a matter of debate and most authorities believe that man alone is responsible for the otter's decline.

Winter cubs In Britain the otter has been found to produce young in every month of the year. In parts of Scandinavia and northern Europe, however, the same species of otter gives birth only in spring and summer. The reason why British otters can breed all the year round may well be linked to the fact that in this country winters are generally mild, a really hard, prolonged winter occurring only about every seven or so years. This means you may be lucky enough to see the delightful sight of playful otter cubs sliding down snowy banks in the coldest months. However, records of winter cubs succumbing to the weather are not uncommon.



Below: Gourmet dinner. It appears that the otter does not prey mainly on large fish, such as salmon and trout, but captures small, slow-moving fish such as roach and chub. For every large fish eaten, over 100 small specimens, including eels and coarse fish, will have been taken.
An otter avoids exhausting the food supply of a particular area by having a large home range that extends as far as 12 to 18 miles along a river. It also hunts inland within this district.
In times of severe weather conditions, otters have been recorded raiding chicken runs and helping themselves to the easy pickings of trout hatcheries.




CHRISTMAS TREES
Familiar to everyone as the Christmas tree, the Norway spruce is also one of our most important sources of timber, with large plantations being cultivated in the Scottish uplands.

The Norway spruce occurs naturally throughout much of northern and central Europe in both lowland and mountainous regions; in the Alps and the Pyrenees it can be found growing at altitudes of over 2000m (6000ft) above sea level. In more sheltered locations it can grow to a height of 60m (200ft).

Fossil records show that thousands of years ago the Norway spruce was native to the British Isles, but then came the great Ice Ages which forced the tree south into warmer parts of the Continent. With the retreat of the Ice Ages, the Norway spruce failed to return naturally to the British Isles, and it was not until the 16th century that it was re-introduced by man. During the next two centuries it became increasingly popular among landscape gardeners, and for the last two hundred years it has been widely grown as a commercial tree.

Nowadays, it is one of our most common forestry species. As well as being grown for their timber, hundreds of thousands of young Norway spruces are cropped each year to supply the demand for Christmas trees.

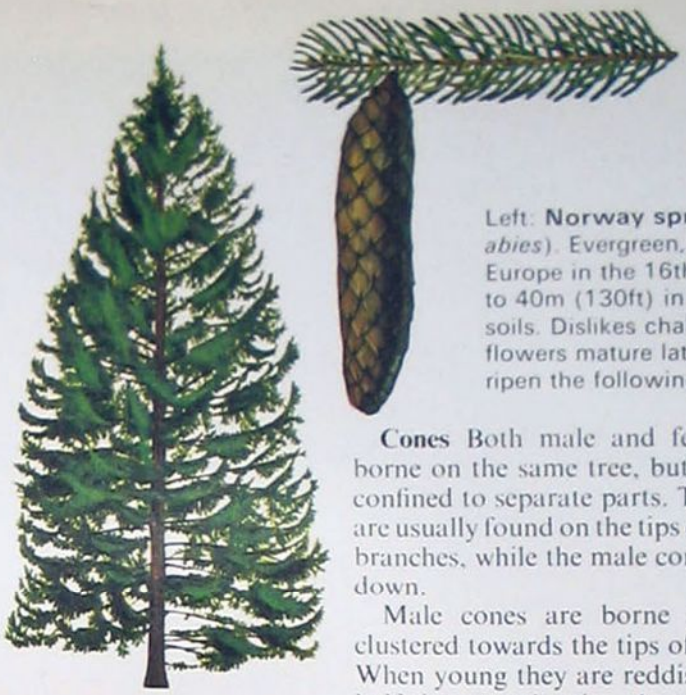
Growth and shape In the British Isles the Norway spruce does not reach quite the height of its Continental cousins. It usually grows to 40m (130ft) and is a handsome tree with a straight trunk tapering gently towards the top. The rather narrow, conical crown is formed by regular whorls of branches radiating out along the length of the trunk. Given enough space, branches develop even at ground level, but in a plantation the dark shade cast by the crowded ranks of trees causes the lower limbs to be shed as the tree grows.

Each branch, radiating out from the trunk, divides into smaller branchlets. These are arranged more or less opposite each other and tend to droop downwards to form a frill. This is especially noticeable in younger trees.

Needle-like foliage Each branchlet is densely covered with needle-shaped leaves of a rich green colour.

Look at these needles closely and you will see that they have four sides and are roughly diamond-shaped in cross-section. Each needle sprouts from a tiny wooden peg in the branchlet. After the needles have been discarded usually after six or seven years these pegs remain behind, giving the twigs a rough feel. On the upper half of the twig, the needles point forward and overlap each other, but lower down they spread out and point away from the twig.

New leaves appear from buds each April or May. The buds are about 5mm ($\frac{1}{4}$in) long and are wrapped in smooth pale brown scales. With the start of the new season's growth they break open, sending out young shoots covered with bright yellow-green needles, in marked contrast to the darker green of older needles. As the year progresses, the new needles darken and the contrast in colour gradually disappears.



Left: **Norway spruce** (*Picea abies*). Evergreen, introduced from Europe in the 16th century. Grows to 40m (130ft) in moist woodland soils. Dislikes chalky soils. Male flowers mature late May, cones ripen the following spring.

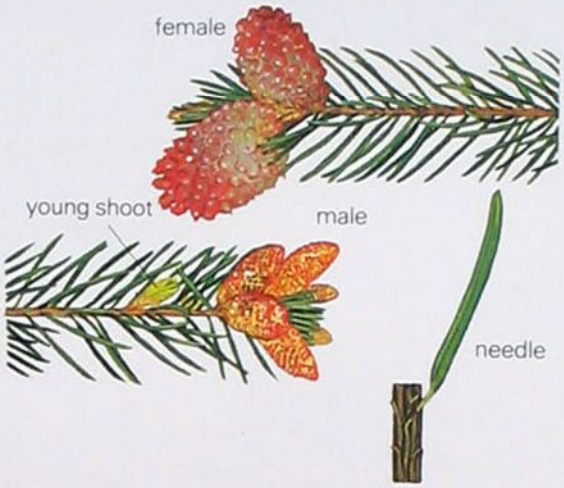
Cones Both male and female cones are borne on the same tree, but they tend to be confined to separate parts. The female cones are usually found on the tips of the uppermost branches, while the male cones appear lower down.

Male cones are borne on short stalks clustered towards the tips of the side-shoots. When young they are reddish, and resemble half-ripe strawberries. As they mature they turn yellow with the production of pollen and reach a length of 2.5cm (1in). They shed their pollen in early May. Such vast quantities are formed that the ground beneath a Norway spruce becomes covered with a dusting of pollen.

The female cones consist of an erect column of overlapping crimson or white scales. After fertilisation they turn green, sometimes tinged dark purple. By the autumn they have turned over to hang from the twigs and have ripened into reddish-brown cones. The cones are covered with stiff papery scales, each of which encloses two developing seeds. Unlike many conifers, which distribute their seeds

Below: A plantation of Norway spruce. They grow best in areas of high rainfall and will tolerate damp ground provided it is well drained. In drier areas they are less happy since their shallow root system means they are not always able to extract enough moisture from the soil, and they become susceptible to drought.

Above: Mature and young Norway spruce cones. A single cone can yield up to 350 seeds, each seed being attached to a wing to help its dispersal by wind.



Right: The male and female cones and leaf. The male cones are borne in clusters at the ends of side-shoots. They are reddish at first, turning yellow in late May. Young female cones are crimson or less commonly white.

only after two or three years, the Norway spruce distributes its seeds the following spring when a combination of sunshine and wind dries out and separates the thin cone scales, thus allowing the seeds to fall out. The seeds are then dispersed by wind.

Plantations and timber Most of our Norway spruce timber is imported from Scandinavia but there are large plantations in Scotland.

Growing the Norway spruce presents a problem because it has a very shallow root system. Instead of growing deep into the soil, as do the roots of most trees, the roots of the Norway spruce spread out just below the surface to become entwined with those of its neighbours. Such shallow rooting makes the tree vulnerable to being toppled by gales, and one falling tree is likely to uproot several near by. On exposed sites, strong winds can flatten large areas of valuable timber.

The wood from a Norway spruce is lightweight and rather elastic, but tough and durable out of doors. It is widely used in the building industry for flooring and scaffold boards. The straight trunks are ideal for telegraph poles and the masts and spars of small boats. The wood is also used for making packing cases, and in parts of Europe the trees are tapped to yield a resinous pitch from which turpentine is extracted. Finally, a lot of spruce wood goes to paper mills, particularly in the vast spruce forests of Canada, the USSR and Scandinavia.

Below: The springy nature of the branches allows them to survive heavy snowfalls without snapping. They are helped in this by the shape of the leaves, which retain much less snow than would a broader leaf.

The Christmas tree legend

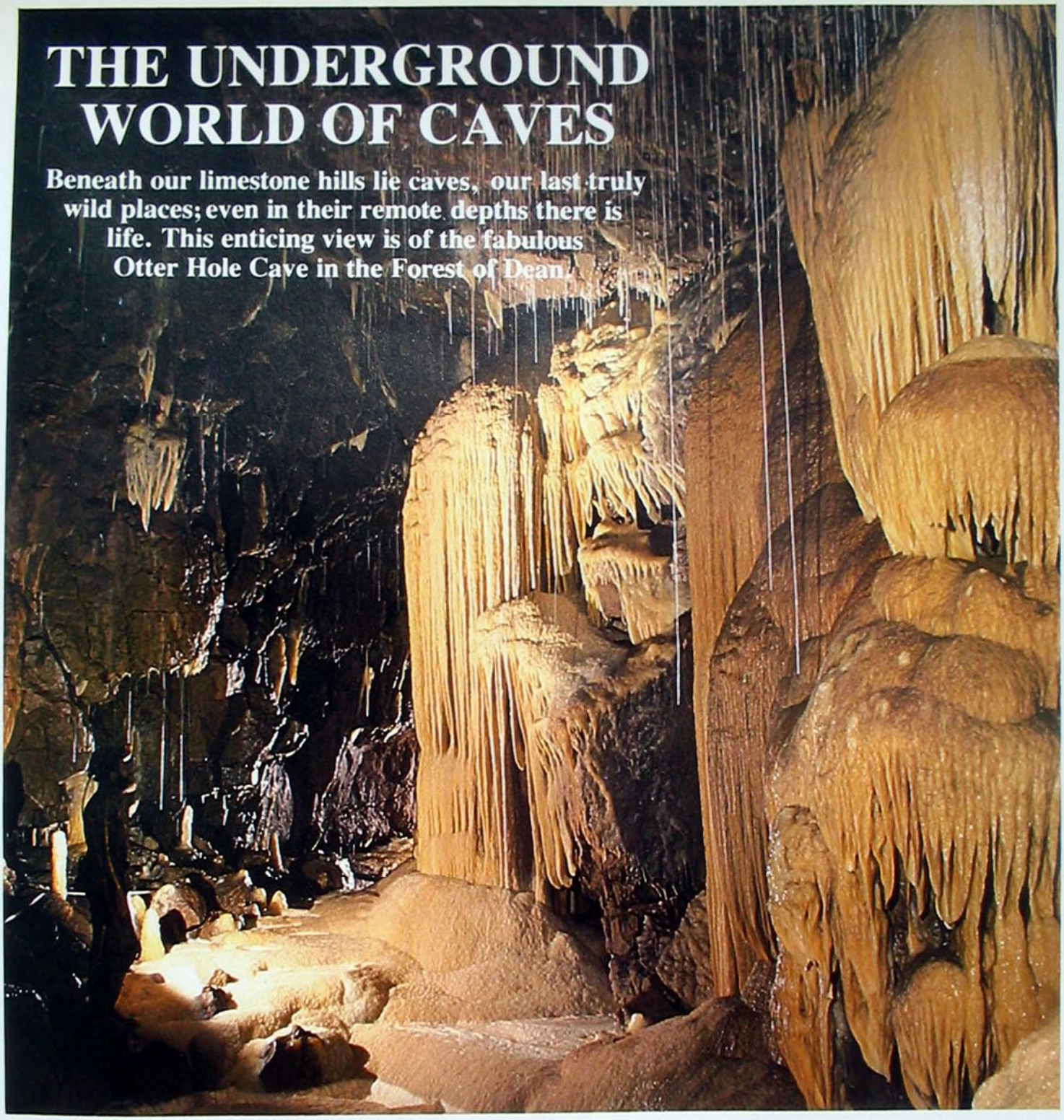
The tradition of decorating a Norway spruce is an essential part of Christmas for people throughout Europe and North America. How this practice began no-one really knows, but it is thought to have originated in Germany during the 17th century.

There are many legends relating to the origin of the Christmas tree. One of the most charming is a German legend that tells how an old farmer and his family were disturbed one winter's night by a loud knock on their door. The farmer found a small boy standing outside, wet through, shivering with cold and weak with hunger. The young lad was promptly dried, fed and put to bed. The next morning the family was awakened by the sound of a choir singing, and they were astonished to see that their young guest was surrounded by a shining halo – for he was the christ-child himself. The boy departed, but before doing so he snapped a branch from a nearby spruce tree and stuck it in the ground, saying that the branch would flourish as a symbol of the good fortune with which the kind family would be blessed. Since that day, the legend goes, the Christmas tree has stood as a symbol of goodwill.

One of the most famous Christmas trees in the world is the one erected each year in London's Trafalgar Square. Every December a 20m (70ft) Norway spruce is shipped to this country. The tree is a gift from the people of Oslo in Norway to the City of London in appreciation of the role played by Britain during World War II. A special lighting ceremony marks the hand-over, and at the flick of a switch the tree is lit by 650 light bulbs.

THE UNDERGROUND WORLD OF CAVES

Beneath our limestone hills lie caves, our last truly wild places; even in their remote depths there is life. This enticing view is of the fabulous Otter Hole Cave in the Forest of Dean.



What could be more mysterious than an ancient, rock-bound chasm opening into the earth's surface, gulping a fast flowing stream into the darkness below? Its dank interior seems an unlikely home for any living creature. The rough rock walls glisten with beads of water, and the floor is of sticky, orange-brown clay. The only other colours are the varied hues of brown, interrupted by the glistening white of what look like slender hanging straws. These are stalactites in their first stage of growth. But life is persistent and astonishingly adaptable: take a close look at a mud bank or a wall-pocket, and there you will see living things–small creatures that hop and scurry about. The cave fauna are an unsuspected, improbable community, linked to the outside world only by trickling water and the coming and going of swirling bats.

Food from outside Life revolves around the sun. Green plants trap solar energy and manufacture food on which animals depend. But light penetrates only a few metres into the underground world so that no green plants can live in a deep cave. However, fragments of twig and leaf may be carried from the surface into the depths by a stream, and may be stranded on its banks where small scavengers of plant remains can reach them. The droppings of visiting bats still hold a little food energy from the bats' rich diet of insects caught in the air above fields and

Cave formation

Rainwater, weakly acidic after its passage through the soil, corrodes its way into limestone along lines of weakness. At first the channels are tiny, but some enlarge and capture the main flow. As water is conducted away, passages are drained and cavers can enter. Our major caving areas are in the Yorkshire Dales, the Peak District, the Brecon Beacons and the Mendips.

Above: A herald moth hibernating on the cave roof. In the course of time water droplets have condensed on its wings from the saturated air. Herald moths are commonly found hibernating in the transition zone of many British caves from late autumn till spring. They may otherwise hibernate in barns, belfries, roofs and under the arches of stone bridges.

woods. This energy is passed on to the cave flies, beetles and millipedes which feed on the droppings.

A niche for winter The huge rock mass in which the cave lies is little influenced by short-term changes in temperature so that the interior remains at about the mean annual temperature, summer and winter alike. This makes caves ideal hibernation sites for bats and insects. Bats are frequently found in Devon, Somerset and in the Welsh caves, but further north they are scarce below ground. The insects that hibernate in caves – the herald moth (*Scoliopteryx libatrix*), the tissue moth (*Triphosa dubitata*) and various flies and mosquitoes – are widespread in all British cave areas.

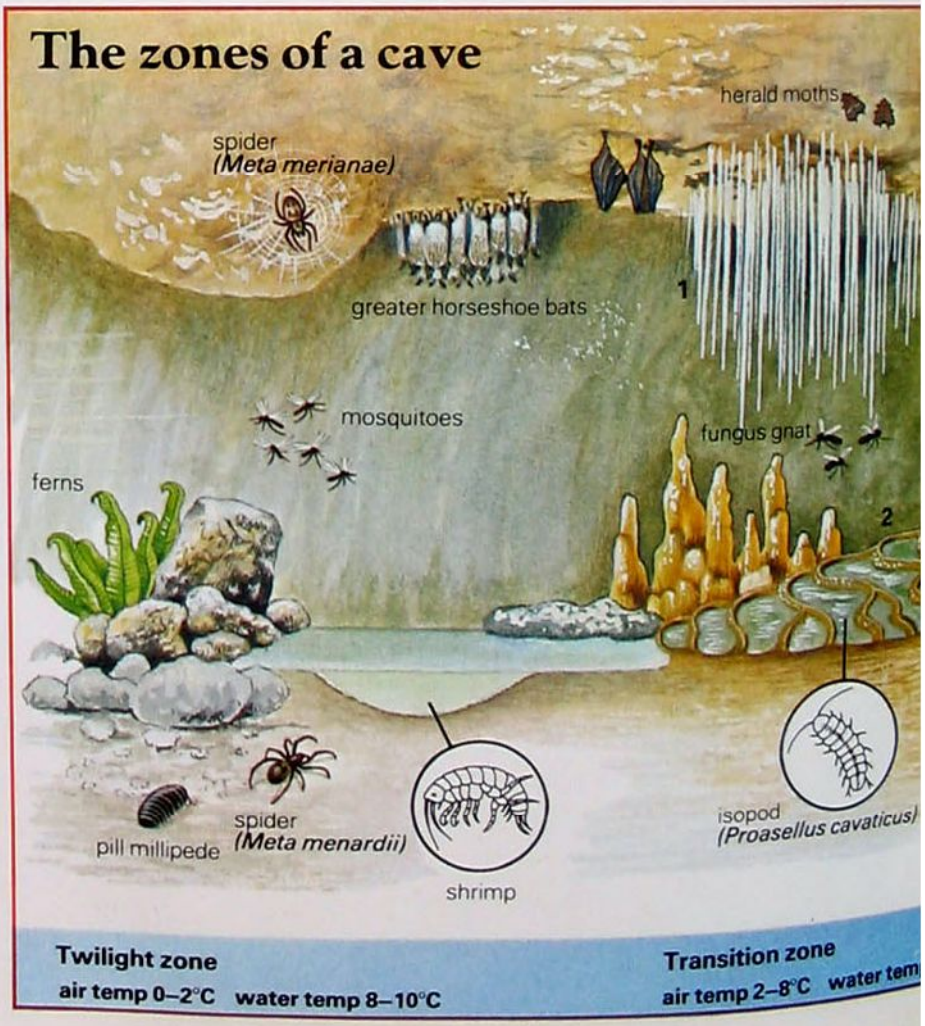
Cave dwelling has its own problems, even for the temporary winter visitors. Most obvious is the lack of light. Bats have excellent hearing and can rely on ultrasonic squeaks to pinpoint even the smallest obstacles as they fly through the cave. The slow-moving invertebrates on the cave floor are able to use their antennae to feel their way, while an acute sense of smell will guide them to their food.

Hazards of hibernating There are, however, more subtle problems, one such being the draught. Many caves have two or more entrances, and if these are at different heights an air current is generated. In winter the cave is warmer than the outside world, so the relatively warm air rises out through the upper entrance, to be replaced by cold, denser air that streams in at the lower entrance. The cave walls impart their warmth to the new air, which then rises and continues the flow within the cave.

This chimney effect can cause serious problems for hibernating animals. As cold air warms, it exerts a drying effect on cave walls and their inhabitants. The small insects have extremely limited water reserves, and would not take long to dehydrate. Even bats are threatened. They may cluster closely to trap moist air between their bodies, or may snuggle deep into narrow roof crevices, away from the drying air current. Usually, however, they try to find a blocked cave, free from any draughts, in which to roost, precisely to avoid this problem.

While dry air may cause problems for the species that visit the cave, saturated air may be more difficult to cope with and has led to even more radical adaptations. An insect's equivalent of blood (the haemolymph) has a high content of water but in a cave the air can become extremely moist, and in such conditions – which are normal in the deep cave – some of the water may be absorbed into the body fluids of the insect. This leads to water poisoning unless the insect has a way of getting rid of the excess water. Freshwater animals possess a kind of water pump which keeps their body fluids up to the right concentration, and many of the deep cave creatures have developed one too.

Land or water animals? With the problem of water balance solved, there is little or no distinction between the land and water-dwelling creatures of the deep cave. 'Aquatic' animals such as the shrimp-like amphipod *Niphargus fontanus* and the isopod *Proasellus cavaticus* (a small white water louse) move from pool to pool across the damp cave floor. They may be joined in the water by 'terrestrial' millipedes, beetles and the small, knobbly woodlouse *Androniscus dentiger*. Having once adopted an aquatic type of water balance system, the deep cave specialists cannot cope with dry atmospheres, and this is one factor that restricts them to caves.



Permanent cave dwellers So many creatures are dependent on caves and unable to live elsewhere that biologists have given them a collective name–troglobites. Many of them are blind, white invertebrates–dwelling in total darkness they have no need for vision or body pigment, and in the course of evolution they have lost both. In Britain most aquatic troglobites are confined to the south west, south Wales and East Anglia. These are areas south of, or only just north of, the southern limits reached by the great ice sheets during the most recent ice age.

The ice sheets probably wiped out all cave specialists in the area beneath them, but the creatures are slowly inching back northwards year by year, using flooded crevices in the rocks and deep gravel beds of rivers as migration routes from one cave region to another. They cannot follow surface migration routes because, lacking any form of skin pigment, they are completely unprotected from the damaging effect of ultraviolet light in the sun's rays. For them, daylight is therefore lethal and they are trapped underground for ever.

Saving precious energy Food is in short supply in the deep cave, and some troglobite specialisations are effective in saving energy and therefore food. These include slow rates of growth and great efficiency in movement and the actions needed to capture prey or take plant food. Another adaptation is the ability to breed successfully by means of a single egg, or only a few eggs. This compares with the myriads of eggs laid by many other creatures, for example insects.

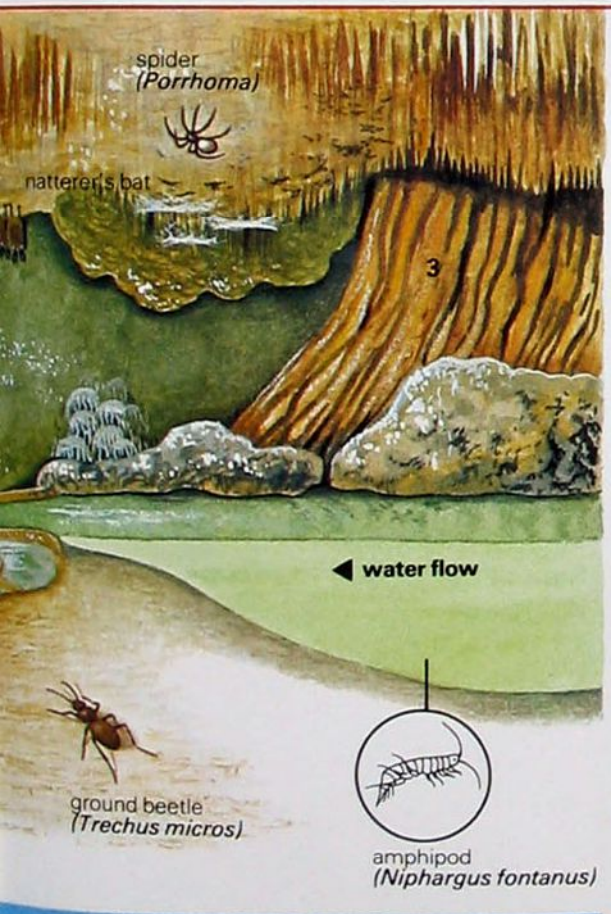
Above: A cave spider, *Meta menardii,* keeping guard over its egg sac.

Right: *Proasellus cavaticus* is an isopod, related to the woodlouse, that can be seen in caves of the Mendip Hills and South Wales. This one has made its home in a film of water on a flowstone bank, where it grazes on patches of bacteria. These are visible in its gut as a dark central line running along the body.

Many of the deep cave insects have lost some or all of their larval stages of growth, and it is thought that this may also act as an adaptation that saves energy. The process of metamorphosis often involves peak periods of feeding which, in the inhospitable cave environment, may simply not be possible.

Troglobite eggs are unusually well stocked with food so that the young are big and strong when they emerge, and thus are well equipped for survival. A troglobite species can therefore avoid the high wastage–in loss to predators or in mortality of other kinds–that is often a feature of life for wild populations.

Plant life in the dark While green plants are absent from caves, many lower plants manage to eke out a living. Fungi feed on washed-in vegetation and may take a heavy toll of hibernating insects whose resistance to fungal infection may have been lowered by water poisoning. Even further down the evolutionary scale are the organisms that form powdery patches on cave walls. Looking like lichens and often called wall fungi, these are members of a group called the actinomycetes. Their colonies are often beaded with small water droplets, giving them a jewel-like appearance in the caver's headlamp.



Conditions for life In a cave, as in many other habitats, variations in living conditions produce a series of life zones, each with a distinctive community. The twilight zone reaches the limit of light penetration, the dark transition zone beyond has a variable climate, while the deep cave has a steady temperature and saturated humidity.

Water-formed stone Stalagmites stand and stalactites hang. They are the accumulated mineral deposits from dripping water. Straw stalactites are in the process of being formed (**1**). Rimstone is formed at the rim of a pool as water slowly overflows (**2**). Flowstone (**3**) is made when a film of water flows down a sloping surface, depositing a smooth sheet of calcite.

Bacteria are everywhere in the cave and, together with fungi, form the main food of the animal community.

The food chain Tiny springtails are voracious feeders on the spreading branches (hyphae) and spores of fungi. They often cluster on pool surfaces where most predators cannot venture and where the humidity is always high. Those braving the cave walls face the danger of blundering into a spider's web, where certain death awaits them. Most cave spiders belong to the genus *Porrhomma*, which is one of the genera of money-spiders. Our only cave-limited spider is the rare *Porrhomma rosenhaueri*. Occupying another lowly position in the cave food chain are the tiny pink worms that live in mud banks. These, the enchytraeids, are easy prey for the small ground beetle *Trechus micros* which, in Britain, is thought to breed only underground.

Upsetting the balance The cave community is perfectly adapted to function on a tight energy budget. Many troglobites survive with population densities at such a low level that even a slight drop in numbers can consign them to local extinction, and recolonization can be slow. Fortunately the deep cave is a stable habitat.

Even so, man's influence can reach into the depths of a cave. Tipping nutrient-rich sewage or refuse into a convenient sinkhole may solve a problem for the farmer, but it can have serious effects on the ecosystem in a cave below. While the slow-breeding troglobites are for once comfortably provided with food, the less cave-adapted species undergo a population explosion amid such plenty.

Numbers–first of the primitive plants, then the herbivores which eat them, and finally their predators–build up rapidly. The predators wreak indiscriminate havoc among their prey, troglobites and non-specialised species alike. Eventually a steady state is regained, but in the upheaval the troglobites may well have been wiped out: it will be many years before the community recovers its original variety and balance.

Above: Blind and spindly legged, the tiny spider *Porrhomma rosenhaueri* is known in Britain in just two small caves in Wales. It spins a gossamer sheet-web in remote crevices, to catch the pinhead-sized springtails on which it feeds.

Right: Most cave fungi do not produce fruiting bodies and when they do they are unlike the familiar mushrooms above ground. They can only develop if a large enough supply of food is provided–for example, a dead insect.

Below: The entrance is the only part of the cave where light is sufficient for plants to occur naturally–here are ferns, mosses and grass.

Limestone quarries However, such inadvertent tampering with the balance of cave life is of less importance when compared with the wholesale destruction of the cave habitat by quarrying. Extensive caves in Britain are developed only in limestone. Fortunately we have plenty of cavernous limestone, but the perpetual need for cement, road aggregate and building stone can only be met by blasting away limestone hillsides with their unique fauna and flora. Conservation bodies are taking a new interest in caves and the Nature Conservancy Council has denoted a number of caves throughout Britain as Sites of Special Scientific Interest–a first step towards ensuring their future conservation. This signals an increase in public awareness of the special role of caves as yet another fascinating habitat.

WINTER-THRIVING WOODLAND MOSSES

Lowly, primitive mosses very often remain unnoticed, although they are everywhere around us in the countryside. They are most obvious in the winter months, when they are often the only green colour in a woodland shorn of summer vegetation.

Many mosses grow only in particular types of woodland, either because they are sensitive to the acidity or alkalinity of the soil, or because there is not enough light or space for them to flourish. This river bank in the New Forest (above) provides the ideal conditions for mosses, as well as for the ferns and primroses seen here. The running water and damp ground conditions encourage luxuriant growth.

Many mosses grow actively in the winter when the climate is cool and the moisture abundant, and they are at their most luxuriant after the winter's growth. In the spring they produce their spore capsules, and then gradually wither and dry as the summer progresses, repeating the cycle when damp conditions return.

A dry stone wall or a tree may appear to have an unchanging population of mosses. However, an interesting study of the rare moss *Grimmia stirtoni*, which has been known for eighty years at a site on a Scottish island, revealed that an apparently stable population of moss cushions was really a constantly changing one. The lifespan of the individual cushions was quite short–a matter of a few months only. This is probably true of a great many mosses, especially those living in harsh situations such as stone walls where new cushions appear each year.

Primitive characteristics Mosses are among the few plants still existing that retain some of the characteristics of the very earliest land plants. They have no 'true' leaves, stems or roots. The moss stem lacks the xylem vessels that are normally used to conduct food and water up a plant stem. Instead, mosses absorb water over their entire surface, and so every moss cell must be within reach of the growing surface to obtain its water supply.

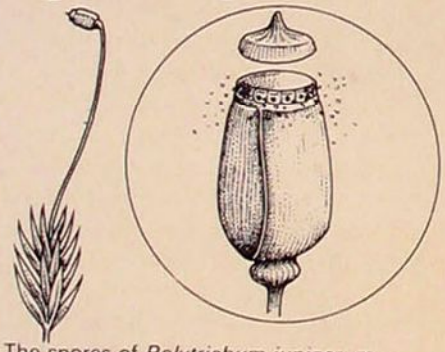
Moss leaves are thin and flat and arranged spirally around the small flimsy stems. True leaves, such as those found on flowering plants, have stomata in their surface–these are pores bordered by special cells that can open and close according to the humidity, allowing air to enter the leaf. Moss leaves do not have these air holes, nor do they have roots, these being replaced by rhizoids–thin hair-like outgrowths that attach them to the ground.

Mosses also differ from flowering plants in reproducing by a system of alternation of generations. A moss plant carries both male and female organs and when the female part is fertilised, the second, or spore-bearing, generation is produced. The spore capsules dry and release spores which, pro-

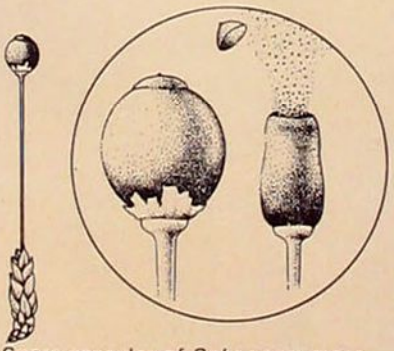
Above: The distinctive spore capsules of this *Polytrichum* moss are covered with loosely fitting caps when young. Mosses such as these are often the first plants to colonize poor soil, helping to stabilise it.

Right: The attractive white fork moss, seen here in its preferred beech woodland habitat, varies in colour from blue-green to grey-green, and is often tinged with silver.

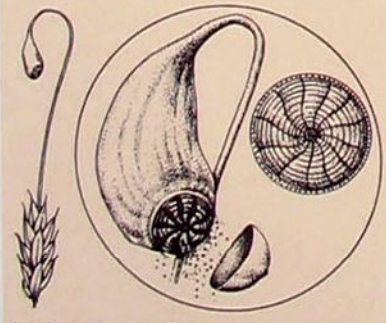
Spore dispersal



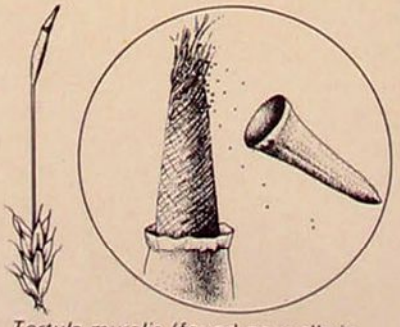
The spores of *Polytrichum juniperum* (found on heaths, moors and walls), are shaken out through pores at the top of the four-sided capsules, when the red cap has fallen off.



Spore capsules of *Sphagnum* moss (found in damp woods and bogs), have a tiny cap that flies off with a pop when the capsule dries, releasing showers of spores.



In dry weather *Funaria hygrometrica* (found in woods and gardens), releases spores through gaps in the top of the capsule. These close up in the damp, preventing dispersal.



Tortula muralis (found on walls in urban areas), has spores covered by spirally twisted hairs. In dry weather, the hairs unwind, exposing the spores to the wind for dispersal.

vided they land in suitable conditions, germinate to form a new moss plant.

Water-loving mosses As mosses need a constant water supply, they grow best in damp or wet places, although some species survive on stone walls or fences, provided the conditions in the spring are suitable for the production of spore capsules.

Some of the most spectacular mosses are seen in very wet places. Upland streams such as those found in Scotland and northern England often arise from springs; the water brings a constant supply of minerals and oxygen to the mosses and liverworts that grow on the ledges and terraces. *Philonotis fontana* forms a bright green carpet in such a situation, and it is often accompanied by the cushion-forming *Dicranella palustris* and many other mosses as well. On the banks of woodland streams species such as *Polytrichum formosum*, one of the hair mosses, and *Mnium punctatum*, grow along with many other mosses and liverworts. The genus *Polytrichum* includes some of the largest of all British mosses and *Polytrichum commune* may reach up to 30cm (12in) in length in very wet conditions among long grasses.

Favourite woodland habitats Not all woodlands contain the same species of mosses, for the vegetation growing in any one area is largely determined by the soil conditions. Beeches grow on a wide range of soil types from the shallow chalky soils of the Chilterns and the Weald to the acid sandy soils of Epping Forest or Burnham Beeches, and the moss population in these beech woods varies according to the soil types. For example, two mosses are common on the chalky soils of the beech hangers (wooded hillsides) so typical of east Hampshire. *Ctenidium molluscum* is restricted to the ground immediately around the bases of the tree trunks, and *Hypnum cupressiforme* grows on the bases of the trunks themselves.

In the woodland of the Chiltern Hills, the soil is often deep and fertile and so a greater variety of plants grows in these woodlands, frequently preventing mosses from growing at all, for at ground level there is little light. By contrast, the acid soil of the beech woods at Epping prevents the decomposition of the autumn leaves and here too, few plants grow in such deep leaf litter. One species, however, thrives in these conditions – the great silvery cushions of the white fork moss (*Leucobryum glaucum*) form a beautiful feature of the woodland floor.

Oak woodlands, often regarded as the native forest of the British Isles, provide a greater variety of mosses than the beech woods. *Atrichum undulatum* and *Thuidium tamariscinum* grow in the damper spots, together with several other slightly less common species. *Thamnium alopecurum* appears on chalky soils, while species of *Polytrichum* and *Dicranum* are characteristic of acid soils.

Above: The aptly named feather moss (*Thuidium tamariscinum*) is found throughout Britain in damp areas—in woodland, on rotting trees, and in shady places. It is a bushy plant, the bright green branched stems growing in thick, feathery tufts.

Pines and birches frequently grow together, particularly on acid heathland soils in Scotland and other upland areas. The ground beneath the trees is frequently covered with heather and other shrubs and, if the cover is dense, little else will grow. If the covering is fairly sparse, mosses such as *Hylocomium splendens* and species of *Rhytidiadelphus* are found. In very wet spots, *Sphagnum* and *Polytrichum* may form small areas of Sphagnum bog.

Tree trunk mosses The number and variety of habitats open to any one moss depends on the climate prevailing in the area. On a large scale, the climate is damper in the west of the British Isles than it is in the east, and so mosses tend to be larger and more common in the west where the conditions are more suitable.

On a tree itself, the distribution of mosses is determined by several factors. Mosses seem to grow more luxuriantly on the north side of a tree than on the south side, and the prevailing wind also affects moss growth, most mosses growing better on the lee side of the tree, out of the wind. A leaning tree trunk is an ideal moss habitat because the rainwater accumulates more readily on it than on a vertical tree trunk. However, once the upper surface of the trunk is covered by mosses, then the undersurface becomes quite dry. This is because the mosses themselves are perfectly structured to trap water between the spiralled leaves on their stems. As the mosses grow in cushions, these water-trapping stems are pressed closely together and the whole plant acts like a sponge. Indeed, in upland areas where the soil is thin and rocks protrude through the surface, mosses may provide an alternative medium for seed germination. It has been found that saxifrage seeds, for instance, germinate better in moss cushions than in soil because of the humus that is built up by the moss.

Below: The glossy yellow or brown carpets of *Hylocomium splendens* are found on heaths, moors and sand dunes as well as in woodland. The transparent leaves are carried on red, branched stems.

Colonizing mosses The water-trapping ability enables mosses to grow in some unlikely situations. Among sand dunes, mosses such as *Polytrichum piliferum* play an important role in the succession from the shifting, unstable main dunes to the vegetation-covered stable fixed dunes further inland. These mosses colonize the sheltered zone behind the main dunes where they are protected to some extent from the wind. They help to stabilise the sand and trap the water that helps other plants to grow. Lichens may already be present, and grasses and other plants follow, until finally pasture land is formed.

Mosses also play a significant part in other successions of plants, notably in the colonization of rocks and screes and of burned ground. Without mosses and lichens, such areas would be colonized far more slowly and would remain harsh and unsuitable for any other plants to grow for much longer periods of time.

BATTLING BIRDS OF OUR WATERSIDES

Coots and moorhens are freshwater birds but, unlike the ducks, they spend much of their time feeding on land, running about on their disproportionately long feet. In the breeding season both species become very aggressive in defence of their territories.

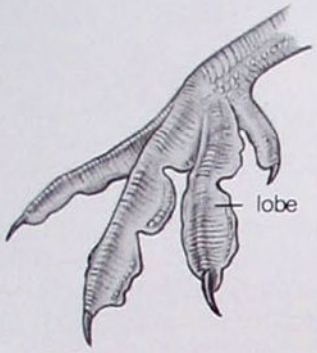
Below: A moorhen among the grasses at the edge of a pond. The bright red beak 'shield' and the white area under the tail distinguish it from the coot. Another characteristic is its habit of jerking its head back and forth as it swims.

The coot and the moorhen, close relatives belonging to the rail family, are common and widely distributed throughout the British Isles. The coot is all black, with a white 'shield' above its white bill, and a faint whitish wing bar (as it does not fly very much, however, this last feature is rarely seen). Its legs are greenish in colour. The moorhen is brown-black in colour, tending to grey on the sides and underparts. Its shield, smaller than that of the coot, is bright red, as is its bill. There is a whitish bar down the flanks, and the area under the tail is also pure white. Its legs are green.

Both coots and moorhens can become totally accustomed to man. Moorhens, especially, breed beside the smallest farm or village pond, and also appear throughout the year on lakes in city and town centre parks. At a distance, both species can be confused with ducks. The moorhen, however, is smaller than most ducks, raises its tail well out of the water, and jerks its head backwards and forwards as it swims. The coot has a rounded, dumpy outline–very different from the straight-backed appearance of most ducks. Once you see the short, pointed bill you can easily distinguish both birds from the broad-billed ducks.

Territory, nests and chicks During the breeding season coots and moorhens defend territories against others of their own species. The area of the territories varies greatly, but

Like ducks, coots swim well and dive for food. Instead of having duck-like webbed feet, however, the coot has broad lobes on each toe (see below) which help to propel the bird through the water. (The moorhen is less aquatic in habits than the coot and has no lobes on its long toes.)



Above: Coots just taking off for flight from a lake. The lobed toes on the feet assist the bird in its laborious take-off from the water surface. To gain the necessary speed and impetus the coot has to patter over the water for several metres. It always looks rather laboured in flight.

Coot (*Fulica atra*); 38cm (15in) from beak to tail; distribution widespread, on lakes and meres. Resident.

Moorhen (*Gallinula chloropus*); 33cm (13in) from beak to tail; distribution widespread, on ponds, marshes, lakes and rivers. Resident.

the coot usually defends a much larger one (up to an acre or more) than the moorhen. Some moorhen territories may be less than 100 square metres (123 sq yards) in size. The territories provide all that the pair needs in the way of food and nest sites.

The nests of coots and moorhens are built of dead leaves and the stems of rushes and other water plants. They are often placed in shallow water among concealing vegetation, sometimes anchored to the bottom, but often just floating on the water. Moorhens, more than coots, also build on dry land, occasionally a little way off the ground in thick bushes. A shallow cup at the top of the nest is lined with green leaves and finer material. Both species lay between six and nine pale buff eggs that are liberally spotted with brown.

Young coots and moorhens are able to walk and swim within a few hours of hatching; moorhen chicks tend to stay close to the nest for the first few days at least, returning to it to be brooded by the parents at night or in cold, wet weather. Around the time of hatching the adult male coot builds one or two 'platforms' within the breeding territory. These are similar to the nest but flatter on top and are provided with one or more ramps leading up from the water. The young coots are brought to these platforms and brooded there rather than in the nest.

The young of both species are blackish in colour, with reddish heads. In the case of the coot this colouring comes from the tips of the down plumules, but the moorhen's head is bare–it is the skin that is red. This colour also extends to the bills and tiny shields of the young of both species. The bright colour in the middle of the reddish head shows as a central 'target' area for the parents who are feeding the chick. It is noticeable that as the young grow and begin to feed themselves, the reddish colour fades.

Threat and aggression

threat display

fighting

Above: The outstretched neck, raised wings, fluffed plumage and conspicuous presentation of the red shield (left) are typical moorhen display postures. If neither bird gives way after display, fighting begins. The birds come together breast to breast, rearing up on their tails to strike at each other with their feet (right).

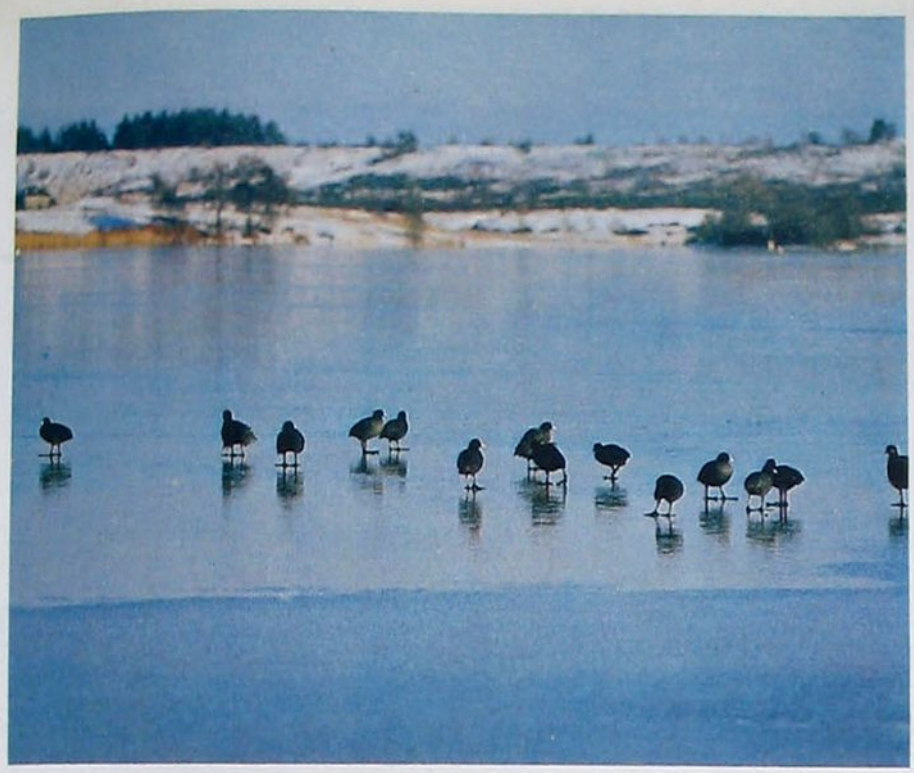
Below: The threat display of the coot.

In defending their territories, both species become aggressive, displaying vigorously at intruding birds and often fighting with them. The white frontal shield of the coot, and the red one of the moorhen, are the principal 'signals' used to indicate aggression. The bird holds its head low over the water, with neck outstretched, then fluffs up its plumage and slightly raises its wings. As well as making the bird look larger, and therefore more threatening, the shield is effectively presented to the opponent against a background of black feathers.

Two moorhens in a dispute, perhaps at the boundary of their territories, not only fluff themselves up to show off their shields, but also cock up their tails and swim round so that their brilliant white undertail feathers show to maximum advantage. If neither bird gives way after this, they rear up on their tails, coming together breast to breast and striking at each other with their feet. Sometimes the long claws interlock and the two birds tumble over and over, even rolling into the water (if the encounter was started on land), and generally making a considerable commotion. It is not uncommon for the mates of the fighting birds to join in so that all four moorhens form a flapping, grappling mêlée. The fights can end in one of two ways. Either one bird, or pair, gives way and is chased off by the victors, or the combattants mutually decide that enough is enough, and they break off and retreat slowly from each other, hunched and ready to resume battle at the slightest sign of further aggression.

The coot indulges in similar fighting, preceded by showing off its white frontal shield. It also raises its tail and swings round like the moorhen but, as the underside of its tail is black, the significance of this is not so obvious. Fights between four birds–two pairs–occur as with the moorhen. All four may be involved in one scrap, but not uncommonly the two male birds and the two females have separate fights alongside each other.

Aggression and fighting is very important as each pair of birds tries to establish a territory large enough for its breeding and feeding needs. Actual damage during the fights is rare: as in most close encounters between birds, the winner, if there is one, is the stronger or older bird, and the loser gives up before it gets injured. Researchers have found some evidence to suggest that the same pair of birds return in spring to hold and defend the territory they had the previous year. This certainly happens with some moorhens, but it has not yet been conclusively proved that the same thing happens with coots.



Above: Coots walking on ice. They rarely breed on waters of less than an acre in extent, but in winter appear in flocks on many town park lakes, becoming completely tame and joining the swans and ducks in taking food from people. The rounded, dumpy silhouette of the coot, clearly visible here, distinguishes it from most ducks, which have straight backs.

Adaptation to life in the water

Water is an attractive habitat for birds: it is fairly safe from land predators such as cats and foxes, and can provide a great diversity of food. To help them swim, the feet of water birds are often lobed (coots and grebes), or webbed (ducks and gulls). Penguins and puffins actually 'fly' under water, using their stiff, flipper-like wings. Birds that spend most of their time on water need warm, waterproof plumage. A thick layer of down keeps out the cold and traps air which helps the birds float. The down is covered by long overlapping body feathers that prevent any water from penetrating. To keep the feather waterproof, the birds must oil them regularly from a special oil gland situated at the base of the tail. The birds rub the oil into their feathers with the bill while preening. Grebes do this after each feeding session, rolling over in the water to oil the feathers on the belly. Well-kept feathers are unwettable; water forms droplets on the oily surface and quickly runs away. Land birds also have oil glands, but their feathers are rainproof only, not completely waterproof.

Family affairs The coot normally rears just one brood of young in the year, but the moorhen often manages to raise two, and sometimes even three. In nearly all other species of birds that raise a second brood, the first brood youngsters move, or are driven, away from the nesting area. In the case of the moorhen, however, the young of the first brood help to rear the next lot of chicks. Occasionally they may help to incubate the eggs, but more usually they assist in the feeding of the chicks after hatching.

It is obviously advantageous for the parents to have help in finding food and giving it to their chicks, but it does also mean that the territory has to be large enough for all the birds – parents, first brood young and second brood young – to be able to live and feed within it.

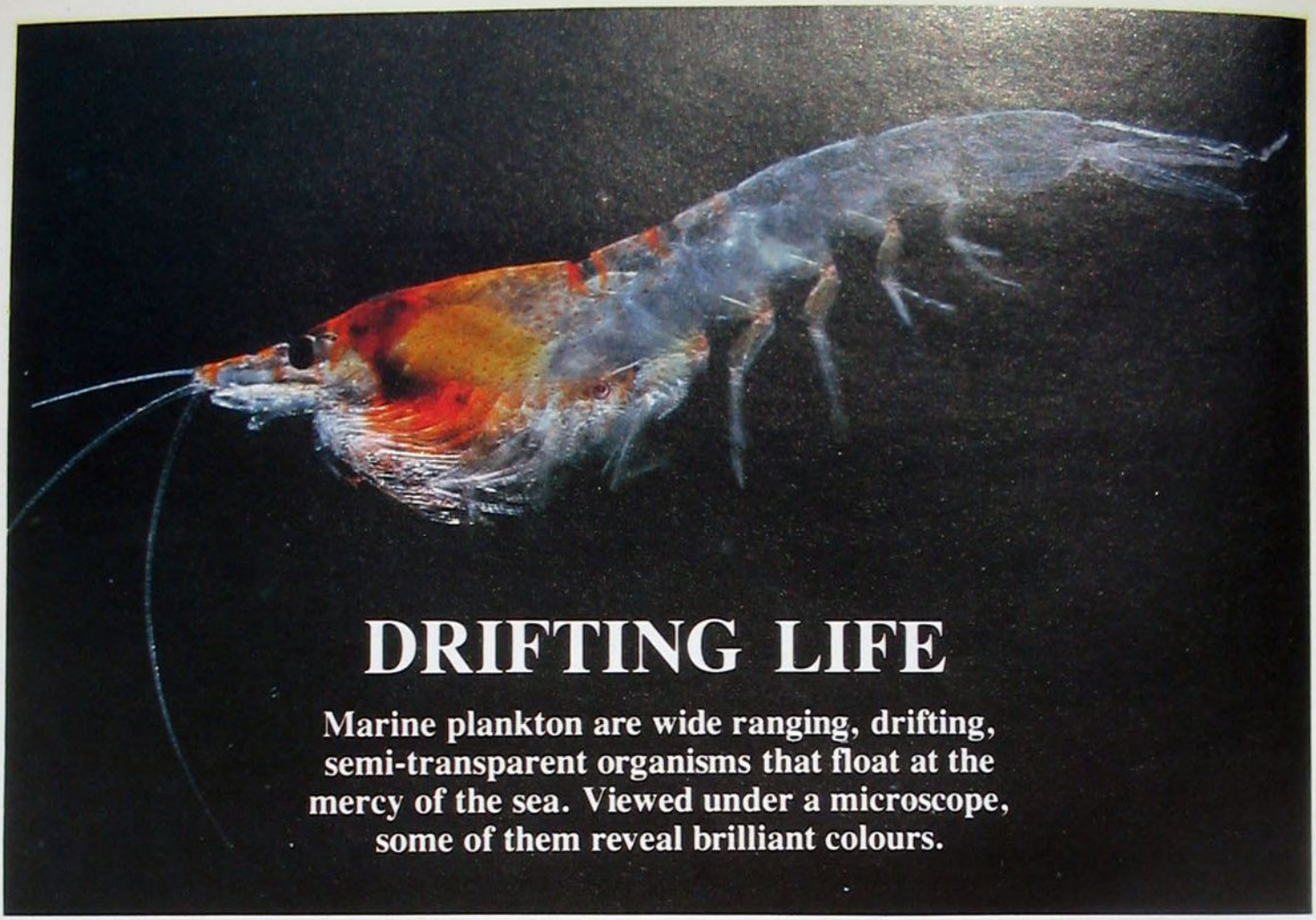
Seasonal movements Moorhens in the British Isles and north-west Europe are almost entirely sedentary. Movements of ringed individuals have rarely been recorded over more than about 10 to 15 miles. Further east, however, where the winters become very icy, moorhens are forced to move away south and west to warmer areas, but few if any come as far as Britain. Many moorhens stay on their breeding territories throughout the year.

British coots, too, are with us all the year round, but are joined by fairly large numbers coming from the Continent to spend winter here. Ringing has shown that these birds come from as far afield as western Russia, as well as from the countries round the Baltic and nearer Britain. For a bird that always looks very laboured when in flight, coots travel surprisingly long distances on migration. Unlike the moorhen, coots spend the winter in large flocks, with few birds staying on their territories. On some of our reservoirs and gravel pits, flocks of up to 5000 may build up.

Diving for food Moorhens are omnivorous birds, eating a wide variety of plant leaves, stems and seeds, as well as molluscs, worms, the larvae of many different freshwater invertebrates, and whatever the generous public feeds to them. They feed on land as much as on the water. When swimming they often dip their heads under water, and even upend, but only very occasionally dive.

Coots, on the other hand, dive quite competently, first pressing the air out of their plumage, and making a little upward and forward leap to give themselves the necessary impulsion to submerge. Normally they go down only about 90 or 120cm (3-4ft), but greater depths, of 4.5m (15ft) or more, have been recorded. Coots are omnivorous, like moorhens, but tend to eat mostly plants. They graze short vegetation on land, and pluck aquatic plants growing in and under the water.

Below: Coot chicks hatching. The red colouring on the head seems to reinforce the strident calls of the chicks as they beg for food from their parents. When the chicks beg they raise their heads towards the parents and sway them slightly from side to side.



DRIFTING LIFE

Marine plankton are wide ranging, drifting, semi-transparent organisms that float at the mercy of the sea. Viewed under a microscope, some of them reveal brilliant colours.

The plankton that live in our seas include both plant and animal types, many of which can be observed only with the aid of a microscope. In all communities, plants are the basic producers of organic substances such as sugar, fats and proteins, and the planktonic community is no exception, the minute floating plants fulfilling this role. These plants form a food source for the grazing animal plankton, which are in turn eaten either by carnivorous plankton or by swimming creatures such as fish or marine mammals. The inter-relationships of the food supply of all these organisms are known as food webs.

Planktonic plant groups Plant plankton, known as phytoplankton, is divided into two groups – the dinoflagellates and the diatoms. The cell content of both groups includes the green pigment chlorophyll that is vital for photosynthesis.

Dinoflagellates are often very small single-celled organisms that bear one or more beating hair-like structures known as flagellae. The flagellae help them to make small movements in the water, but are not powerful enough to counteract currents. The phytoplankton may be of bizarre appearance, like the anchor-shaped *Ceratium* which measures up to 0.4mm in length. The strange shapes and extensions of their bodies help the plants to float and catch the water currents which then waft them around.

The second principal group, the diatoms, are often large and may be composed of a number of cells arranged end to end to form a chain. *Chaetoceros* is a diatom with chains that may be up to 0.07mm in diameter and much longer. They also have strange extensions to help flotation, although they lack the moving flagellae of the dinoflagellates.

Buoyancy aids Phytoplankton can also have additional aids to floating; for example, globules of oil or fat stored inside the cells which make the organisms lighter than the surrounding water and therefore more buoyant. Although they cannot control their destiny in the sea, some kinds are able to adjust their vertical position in the water. The dinoflagellates are stimulated by light and

Above: This shrimp-like creature is an euphausiid, one of the larger members of the marine plankton, reaching about 15mm ($\frac{1}{2}$in) in length. Still larger euphausiids form the Antarctic krill on which the giant whales feed.

Below: Radiolaria and diatoms are beautiful but rarely seen members of the plant plankton. Radiolaria can look like miniature sputniks, with spherical bodies, sculptured shells and rods radiating outwards.

swim towards it by using their beating flagellae. Therefore, the dinoflagellates, and some other phytoplankton, move up towards the surface by day and sink down in the water at night.

Full and part-time plankton The animal plankton, known as zooplankton, is very diverse and includes representatives of many groups of animals. They range in size from microscopic to animals as large as the lion's mane jellyfish (*Cyanea*).

Zooplankton also includes temporary as well as permanent members. Many of the bottom-dwelling invertebrates, as well as the fish, reproduce by means of a larval phase, which become the temporary members of the zooplankton. The larva is generally very different in shape and life-style from the parent, and it remains with the plankton until it is an adult. This is an ideal way for cumbersome, slow-moving bottom-dwellers to disperse and for young animals to grow up without competing with their parents for food or living space.

The permanent members of the plankton include some conspicuous organisms: jellyfishes, comb jellies, worms, sea-snails and sea-slugs, many types of crustaceans including krill and copepods, arrow worms and salps. These are diverse animals but they do all have features in common. These include mechanisms to make them buoyant, such as oil droplets, rafts of bubbles or accumulations of light substances in their bodies, and they are generally transparent or near colourless in order to make them inconspicuous to predators.

Filter feeders Phytoplankton forms the basis of the plankton food chains or food webs, and it is grazed by a variety of animals. Important grazers include the small crustacean copepods, which range from about 0.3 to 3mm in length. They filter the microscopic plants from the sea water as it passes between their mouthparts, which act like a sieve. Along with the planktonic larvae of barnacles and other bottom-dwelling crustaceans, they form an important group of grazing organisms.

In winter, the levels of phytoplankton in the sea drop because the plants are affected by the short daylight periods and low temperatures. In summer, the daylight hours increase and the phytoplankton levels rise sharply, providing more food for grazers belonging to the zooplankton, such as the copepod and crustacea larvae (above). As a result, the zooplankton population increases until, with the onset of winter, the whole cycle repeats itself again.

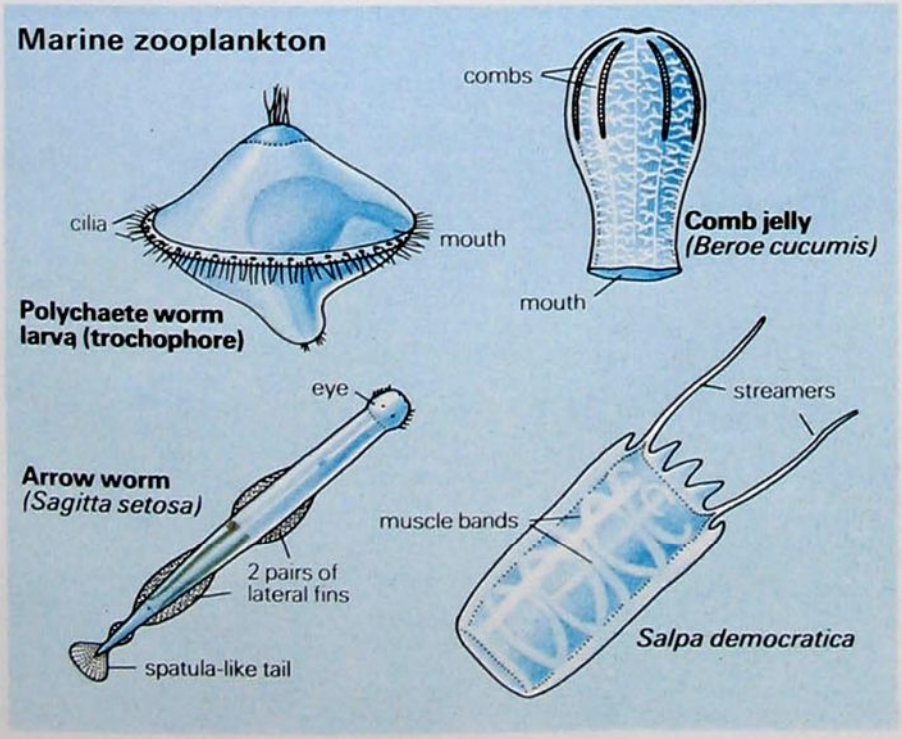
Below: A selection of the larger zooplankton found in the sea. *Beroe,* the comb jelly, may reach up to 10cm (4in) long. *Salpa democratica,* with tentacles up to 30cm (11¾in) long, is sometimes found in chains of individuals.

The crustaceans are not the only filter feeders. The strange salps, looking rather like floating sea-squirts, have a sophisticated filtration mechanism. Salps such as *Salpa* and *Dolium* are able to extract the smallest plants from the phytoplankton, some of which are minute organisms less than 0.075mm in diameter.

Planktonic predators and prey All these grazing animals are, in their turn, food for the carnivorous plankton, or for the non-planktonic carnivores such as the herring which feeds largely on copepods. Salps may be snatched from the sea by birds such as terns, while krill are eaten by whales such as the massive blue whale.

The zooplankton includes a number of creatures that are effective carnivores. These range from the small medusae of the hydroids to the large jellyfish. Both these types of animal catch food with their trailing tentacles armed with stinging cells; the size of the prey can vary from copepods to fish, according to the size of the predator. Comb jellies like *Beroe*, once believed to be close relatives of the sea-anemones and jellyfish, are not equipped with stinging cells. Instead their trailing tentacles, which can be let out and hauled in like fishing lines, bear lasso cells which ensnare small swimming animals like copepods and larvae. So efficient are the comb jellies that they can compete effectively with herring for prey.

Some zooplankton have elaborate mechanisms for detecting the whereabouts of their food. The tiny arrow worms like *Sagitta* detect water-borne vibrations generated by the swimming appendages of crustaceans. Arrow worms are attracted by these vibrations and use the wave patterns as a guide for their sense organs to track down the prey which they finally seize with their minute but voracious jaws.



SKULLS: THE INSIDE STORY

A mammal's skull is a strong, bony box that supports the main sense organs–ears, nose and eyes–and protects the brain. It also provides a firm anchorage for the lower jaw.

The shape of a mammal's skull and head depends to some extent on the lifestyle of the animal–what it eats and which of its senses are the most important (the ears, the eyes or the nose). The sensitive brain, which processes all the messages from the sense organs, is housed in a special protective rigid box of bone–the cranium. The rest of the skull is made up of the face, which contains the sense organs, and the movable lower jaw and its muscle attachments (consisting of a single bone).

Although the skull of each species of mammal varies, the basic structure of a skull is the same in all mammals. There are more than 30 different bones fitted together in a complex three-dimensional jigsaw. The lines where the bones interlock are called suture lines. In a young mammal, whether a human baby or a badger cub, the sutures are not fused. This allows the separate bones to grow and so the skull can increase in size as the brain develops and grows within it. The head grows quicker than the rest of the body and reaches full size before a mammal is fully grown. When the skull is full sized its bones fuse along the suture lines.

The cranium is the name given to the main bones at the back half of the skull; they make a solid box which houses the delicate brain. The only openings in the box are small holes that allow the nerves and blood vessels to enter the skull, and a large hole at the base of the cranium. This is where the spinal cord links with the brain. The bones surrounding this hole are connected to the swivel mechanism, formed by the first two neck bones, that allows the head to move.

Biggest and smallest brains The sperm whale has the biggest brain of any mammal, but this does not make it the most intelligent species. In general, the bigger a mammal is the bigger is its brain–but the proportion of the body weight which is brain goes down as the mammal grows larger. Shrews have the smallest brains but in relation to their size they are about as big as human brains.

The cheek bones form an arch (the zygomatic arch) that comes out from the side of the brain case and curves forwards to join the side of the skull above the hind teeth. In most mammals, like the badger, the widest part of the skull is across the cheek bones. Weasels and shrews, on the other hand, are small mammals adapted for getting in and out of small holes. Their cheek bones start near the front of the brain case so that the width across them is about the same as the widest part of the brain case. The whole skull is fairly narrow and allows the weasel or shrew to investigate a narrow opening. The stoat is of a similar design to the much smaller weasel, but its greater size restricts it from entering small holes after prey–water vole holes and rabbit burrows are its size limit.

Above: Stoat sniffing. The elongated skull and head merge with the long, lithe body of this vicious carnivore, giving it a snake-like shape that allows it to pass through small holes in walls or pursue prey, such as rabbits, down their burrows.

The cheek bones help to protect the eyes and provide the hinges for the lower jaw. In the front area between the cheek bone and the skull, there is the orbit or socket where the eye fits.

At the back of the cheek arch, on the underside, there is a groove where the hinge joint of the lower jaw fits. In the case of the badger, this hinge is such an excellent fit that it will not dislocate unless fractured. This gives the badger an exceptionally strong bite. In fact, once a badger has got its teeth into something, it is almost impossible to make it let go; the jaws clamp together with an unshakeable grip. The real power in a badger's jaws comes from the strong muscles. The main jaw muscles run from the angle of the jaw and are attached to the side of the brain case. The bony ridge (the sagittal crest) along the top of the badger's brain case provides a better attachment for these muscles. When the muscles contract the jaw angle is pulled back and the jaws snap shut. In mammals with powerful bites, the jaw hinge is situated low down in line with the teeth.

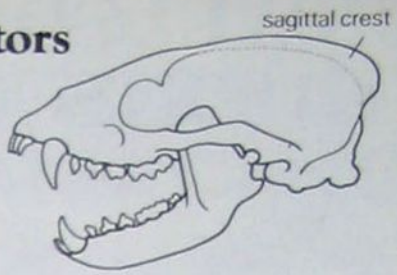
Herbivorous mammals, such as deer are constantly chewing and do not need a powerful bite. However, they do need a chewing action that does not tire the jaw muscles. This is why their jaw hinges are high up, a long way above the line of the teeth. This system 'gears up' the muscle action, giving less power but using less energy for chewing. Deer have incisor teeth in the lower jaw only. These teeth are used to crop foliage by cutting against a leathery pad situated in the upper jaw.

Gnawing rodents shift their jaws backwards and forwards, switching from grinding to chewing and gnawing (with incisors), as well as biting up and down in the normal way. This is why voles and mice have a complex system of jaw muscles.

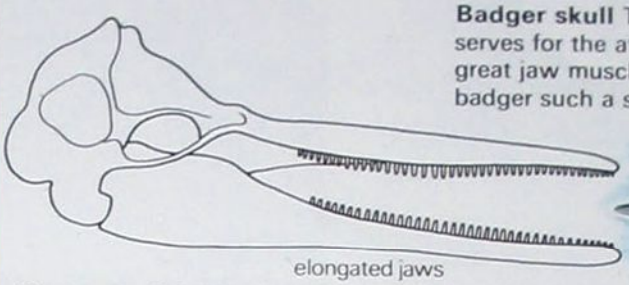
Aquatic mammal skulls Seal skulls and jaws are similar to those of land-living carnivores. But the 'full-time' marine mammals, the whales and dolphins, have skulls with a most unusual shape–the upper and lower jaws being greatly elongated, and containing a large number of evenly shaped teeth. The other peculiarity of whale and dolphin skulls is that the nose opening is on top of the head. This forms the blow-hole through which the mammal breathes when it surfaces. The 'blow' is produced by the release of compressed air from the bronchi and the other air passages after the whale has dived deep.

Special to mammals is the palate bone that makes a roof to the mouth and separates it from the nose cavity. Few other vertebrates have this adaptation. It allows the mammal to keep breathing while it is eating food. A mammal stops breathing for a moment when it swallows food.

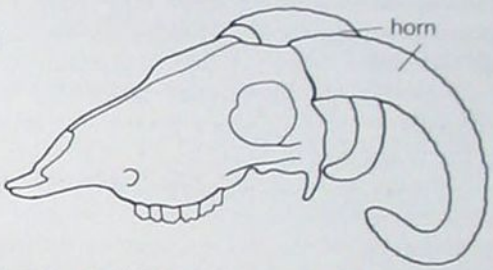
Skulls: bony protectors



Badger skull The large crest serves for the attachment of the great jaw muscles that give the badger such a strong bite.



Common dolphin skull The greatly lengthened jaws contain large numbers of equal-sized, even-shaped teeth for catching fish.



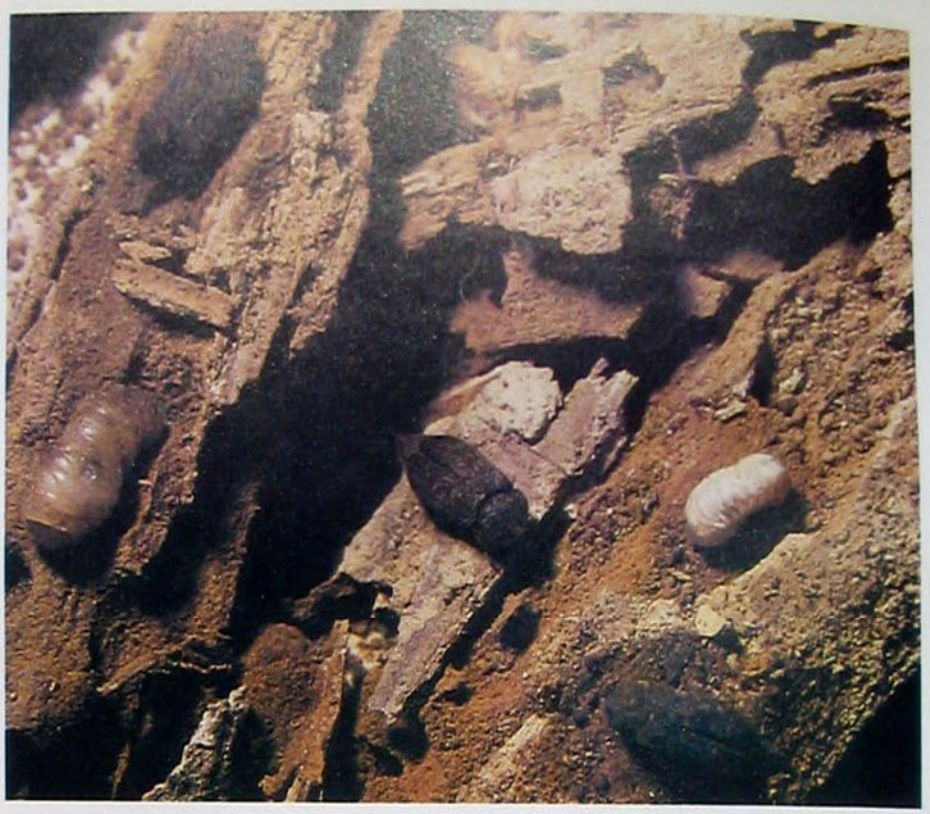
Ram's skull The thick, permanent, hollow horns, supported by a bony core, grow continuously throughout the life of the sheep.

Left: Roe deer in velvet. The antlers of deer are grown and shed annually and consist of a bony core of dense connective tissue that later become calcified.

Below: Blow-hole of a bottle-nosed dolphin. The opening is the nostril through which this totally aquatic mammal breathes when it surfaces. Other whales and dolphins have similarly designed skulls.

UNWELCOME GUESTS AT OUR TABLES

Most people are familiar, to their cost, with the damage caused by the woodworm, or common furniture beetle. These beetles, and others, regularly make their homes with man.



Above: Death-watch beetle – adults, larvae and 'frass' (the debris left by the larvae as they burrow through the wood).

Beetles make up the largest order in the animal kingdom, with over 350,000 species known. Of these, more than 600 kinds have been found in houses and food stores throughout the world. They are carried from country to country by trade and shipping, and although some of our pest species are native to Britain, many are not.

The destructive woodworm One beetle, the larva of which causes damage familiar to most people, is the woodworm, or common furniture beetle. Although most households have had some article of wood damaged at some time, few people know what the beetles look like or how to recognise them.

The adult beetles emerge from the wood through neat circular 'flight holes' between May and August, mating soon afterwards on the surface of the wood or in the holes. You can often see them on the wood surface, on walls, or along window ledges – a sure sign of infestation. The beetles are dark brown in colour, with the thorax forming a characteristic kind of hood over the head.

The female furniture beetle lays an average of 40 to 50 eggs, either in the flight holes or in crevices, joints, or the rough surfaces of wood – sites that are on the undersides and backs of furniture and on the edges of plywood. The eggs hatch after three to four weeks and the larvae start to tunnel into the wood where they spend the whole of their larval existence of two to five years. Their tunnels run mostly with the grain of the wood and are packed with faecal pellets. The larvae are white and C-shaped and thicker at the head end. When full grown they turn their burrows towards the wood surface and make a small chamber just below the surface. Here they turn to pupae and after two to eight weeks the beetles emerge and chew their way through the wood, making the familiar flight holes. Some wood dust usually falls out, giving tell-tale signs of their presence.

The fallacy that only older wood is attacked may have arisen because attacks take some years to develop and be noticed. It is dangerous to store old furniture, such as cane chairs or plywood articles, in lofts or understairs cupboards – the result is often an infestation of roof timbers and stairs. Fortunately, an infestation can be controlled, if caught early, by painting the wood with one of the proprietary insecticides, or injecting it into the flight holes.

Tapper in the night The death-watch beetle is closely related to the common furniture beetle, but is larger and mottled. Its name derives from the tapping sound the beetles make to call to each other – a noise that is particularly obvious in the still of the night. Fortunately for most of us, they damage only old hardwood, such as oak, that has been attacked by fungus, and in addition tend to stay in the same place, which restricts the spread of new infestations. As the larvae bore into the heartwood they cause structural weakening in roof timbers of old buildings such as churches. In nature, death-watch beetles live in decayed trees.

Packet food pests You can sometimes find a packet of food infested with small brown beetles. These could be either the bread beetle (*Stegobium paniceum*), or one of the

Below: Woodworm holes in a plank. For preference, the beetles choose sap wood, which means that floorboards may be badly damaged, while thick structural timbers receive less damage. Fungal decay attracts them, and so do damp conditions. It seems that oak heartwood, mahogany and other tropical hardwoods are relatively free from attack. On the other hand, wickerwork and birch plywood made with animal glue are very susceptible. Chipboard and hardboard appear to be immune.

Above: **Common furniture beetle** (*Anobium punctatum*), and larvae. The adult is 2½-5mm (⅛-⅕in) long, and flies readily.

Below: **Death-watch beetle** (*Xestobium rufovillosum*). The adult beetle is 7-10mm (¼-⅜in) long. It is related to the furniture beetle but is mottled and makes larger exit holes.

Above: **White spider beetle** (*Ptinus fur*); adult has a waisted appearance and longish legs that give it a spidery look. Reaches 2-4mm (about ⅛in).

Below: **Larder beetle** (*Dermestes lardarius*); a blackish beetle, 7-9mm (¼-⅜in) long. The larvae grow to 15mm (over ½in) and feed continuously for one to two months.

Above: **Vine weevil** (*Otiorhynchus sulcatus*); adults reach 9mm (⅜in), while larvae grow up to 10mm (⅜in) and are fat, whitish and legless.

spider beetles, the commonest being the white marked spider beetle (*Ptinus fur*) and the Australian spider beetle (*Ptinus tectus*).

The bread beetle is related to the furniture beetle, but the thorax is not so strongly hooded, and the larvae do not feed on wood. They do, however, feed on a wide variety of dried vegetable products such as seeds, nuts, spices, chocolate and cereals. The adults do not feed. The females lay about 100 eggs in or near foodstuffs and the whitish fat, curved larvae feed for two to three months before making a small cell of food particles in which to pupate. The pupal stage lasts a week or two and the adult beetles live for six to eight weeks. As they also breed in substances poisonous to man, such as strychnine and belladonna, they are known in America as drug-store beetles.

The spider beetles—both adults and larvae—feed on all kinds of dry vegetable and animal material, especially cereals, dried fruit and spices. The females lay about 100 eggs which hatch into fleshy white larvae that take about two months to become full grown. They then make a pupal cell, often by boring into materials on which they do not feed, such as cardboard, thereby causing extra damage.

Larder raiders Another group of beetles which flourish in houses are the bacon and hide beetles, the adults and larvae of which feed mainly on dry animal proteins, such as stored bacon, ham and cheese, and also on dog biscuits, leather and skins.

The bacon, or larder, beetle is probably the one most frequently found in houses and is easily recognised because it is blackish and the basal half of each wing case has a band of pale brown hairs. The females lay several hundred eggs and live for over three months. The larvae are very active, dark in colour and hairy. They feed continuously for one to two months before excavating a hole away from their food in which to pupate—again causing more damage. The whole life cycle takes two to three months, much shorter than that of their relatives, the carpet beetles (see photograph captions).

Pot plant pests Vine weevils can be damaging pests of pot plants inside houses and in greenhouses, being particularly attracted to plants with corms, such as cyclamen and begonia. The larvae live in the soil, feeding on roots and corm bases. The roots of pot plants are frequently destroyed by the white grubs you can find in the soil.

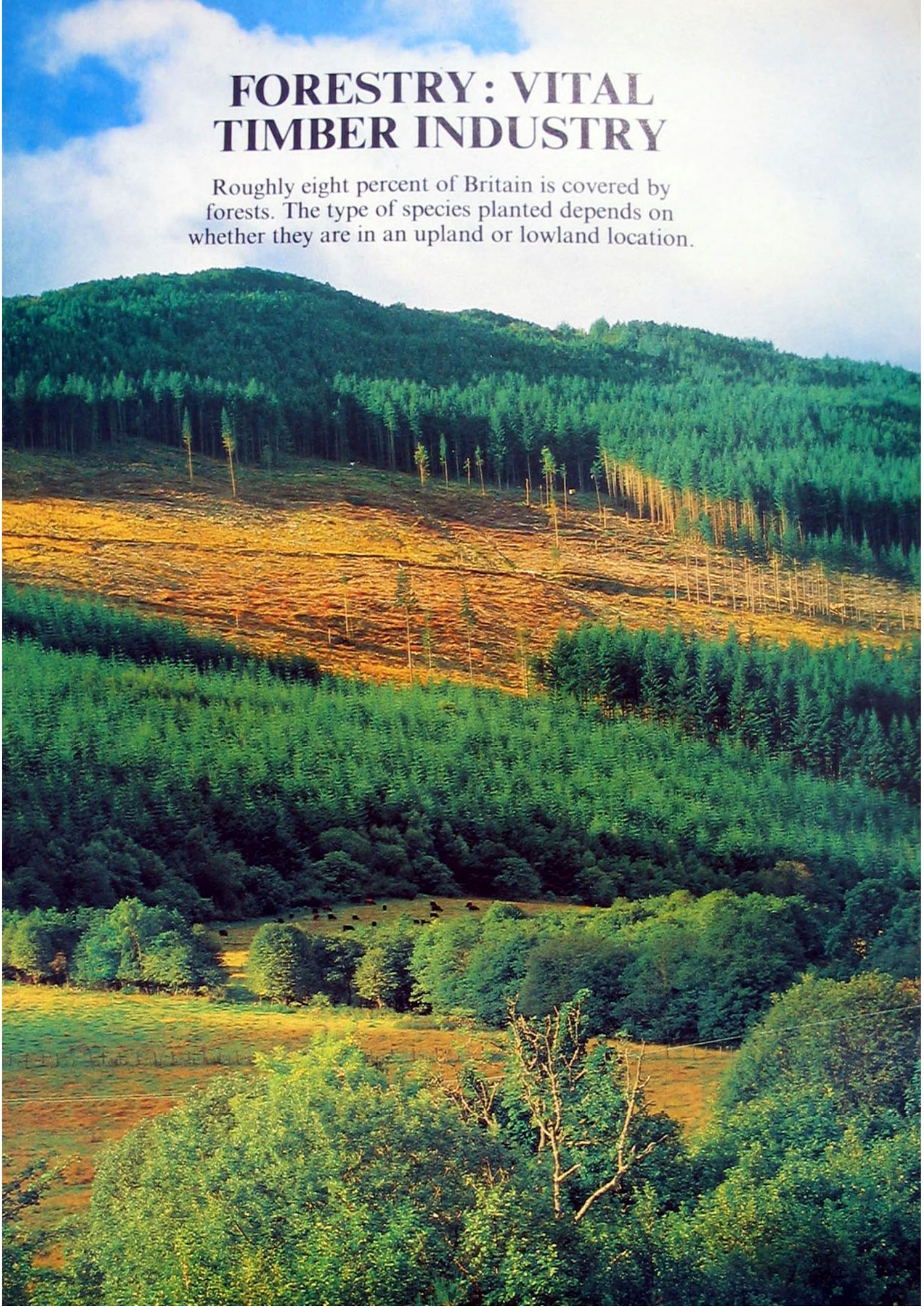
The adult beetles are black with a speckled appearance and elbowed antennae; they walk rather slowly and are flightless. All are females and each can lay up to 1000 eggs without mating (a process called parthenogenesis) over a period of several months, possibly a year. The adult beetles feed on foliage and eat out irregular shaped notches from leaf margins.

Below: Moulted larval cast of the two-spotted carpet beetle. Before turning to pupae, the larvae feed for six to nine months on dried animal remains—furs, woollen fabrics and carpets—and are also partial to dead insects. They can reduce a dried collection of insects to dust very quickly. The whitish, hairy larvae are called 'woolly bears', and make irregular holes in fabrics—without the webbing and pellets typical of clothes moth attacks.

Right: Adult two-spotted carpet beetle (*Attagenus pellio*). This, and a related species, the varied carpet beetle (*Anthrenus verbasci*), appear on walls and window sills in summer. They feed on pollen and nectar, the females flying indoors from the flowers to lay their 100 or so eggs on any suitable materials, including clothes and carpets (particularly if soiled). These beetles are related to bacon beetles and reach 2-5mm (⅛-⅜in) in length.

FORESTRY: VITAL TIMBER INDUSTRY

Roughly eight percent of Britain is covered by forests. The type of species planted depends on whether they are in an upland or lowland location.



Right: A young hardwood and conifer plantation at Ashridge in Hertfordshire. Conifers are quite often planted among slow-growing trees, such as beech, because their faster growth encourages the growth of the hardwood trees upwards towards the light.

Opposite: Dense growth of conifers at Delshangie Wood, Glenurquhart Forest in Scotland. The aftermath of clearfelling resembles a battlefield: a chaos of stumps, branches and churned up soil. Yet within a year replanting starts, and in a few years no trace of the destruction will be visible.

In prehistoric times, some two-thirds of the British Isles was covered in forests. Over the centuries the figure has dwindled to about 4%, and for the best part of this century re-afforestation has been the main concern of foresters. The Forestry Commission was established after the First World War to ensure new planting, and since 1945 it has worked in partnership with private woodland owners. There are now over two million hectares of woodland, and the Forestry Commission plans to double this by the 21st century.

The forester's first requirement is a suitable site. However, with our huge population in a group of relatively small islands, such land is at a premium. Agriculture and towns claim the better sites and soils, so the land available for forestry is usually in upland areas: places where trees once grew before sheep farming put an end to natural tree regeneration, and where the soil became progressively impoverished by over-grazing.

An early problem for foresters was to find tree species that were hardy enough to tolerate harsh, exposed conditions and relatively infertile soils, and at the same time produce enough useful timber. Scrub oak, silver birch and, in northern areas, Scots pine, were three of the most common native species, but they could not provide timber in sufficient quantities and of large enough size. So foresters looked to Continental Europe and north-west America and found two trees that seemed ideal: the Norway spruce and Sitka spruce. These two species are still the ones planted most today.

Seedlings Re-afforestation starts in the forest nursery, which is usually a flat, sheltered site where the soil is easily worked. A roto-vator prepares the seedbeds in spring and the tiny seeds are broadcast sown, then covered with fine gravel, and finally netting to keep off birds, particularly finches. A year later, when the seeds are a few inches high, they are lifted and transplanted in neat lines in another part of the nursery. The soil is well fertilised to encourage the transplants to develop strong, fibrous root systems which will stand them in good stead when they are moved to the planting sites in 18 months to two years time.

Preparing the site Before the new trees arrive, the new forest site itself needs considerable preparation. More often than not the land is badly drained, something that must be remedied since trees do not like standing half the year in water. Nor do they

Below: A dense growth of young larch leafing out in May in the New Forest. Even if it seems difficult to identify a larch plantation from a distance, there is no problem in winter, for the larch is our only conifer to shed its needles in autumn. Larches are highly valued for their quick growth and resilient timber.

Above: The interior of a larch plantation. Larch plantations can support a greater variety of wildlife than most other conifers; their delicate needles and deciduous habit allow more light to enter the forest.

like the hard, impervious layer, or pan, often found near the surface of degraded soils. This layer prevents tree roots from penetrating deep enough to reach growth-supporting nutrients and stops the trees acquiring the stability they need to be able to stand for decades.

Forest ploughs hauled by tractors dig deep down, breaking the pan and providing a channel for excess water. They turn up a continuous slice of sub-soil that smothers the surrounding heather and grasses. The young trees are planted with the help of special planting spades. The transplants are heeled into notches cut in the soil at 2m (6ft) intervals. One man can plant at a rate of about 1200 plants per day. With spacing to allow for access rides, about 2500 trees are planted per hectare.

Protection Young trees need protection; in new plantations the main threat to their survival comes from sheep, rabbits, and, in many places, deer. The whole plantation is enclosed with durable fences of appropriate patterns which exclude these animals. Within the fence trees may be threatened by smothering weeds such as grass and bracken. These weeds are cut away by hand sickles or by tractor-driven swipes run up between the rows. Weeding is easy and fast because the trees are planted in straight lines.

As the trees grow taller and their lower branches begin to meet those of their immediate neighbours, competing vegetation is suppressed and the forester can then leave his trees alone for 12-15 years–apart from maintaining fences, keeping a close lookout for insect and fungal pests and fire (the biggest danger of all). Given good luck, the trees grow with increasing vigour each year, and new long leading shoots give ready evidence of their well-being. As the individual plants compete for light they draw one another upwards, and at the same time give each other protection.

After 15-20 years the forester cuts out those trees which will impede the growth of the better trees. A given area of land can support only a certain volume of timber, either in many small trees or fewer, larger specimens. Since these upland trees are being produced for the sawmills (the thinnings go to the pulpmills), the final crop trees must have space enough to permit ample development during the 60 or so years they are growing.

Lowland sites Not all the forestry planting sites are in the uplands: sheltered valleys and lowland sites are also available, and here a wider choice of tree species can be made. However, conifers are usually planted because they grow much faster than deciduous hardwood trees, and it is softwood that the market wants. Douglas fir, larch and Corsican pine (much of Thetford Forest in East Anglia is Corsican pine, a more rapid producer of timber than our native Scots pine) are species most commonly planted in the better, sheltered places. As the soil is of higher quality, these species can be planted without deep ploughing, but they still require the same protection from animals, weeds and fire.

Hardwood forests The long-established hardwood forests are found in lowland Britain and they are mainly of oak or beech.

Left: A temporary sawmill which has been set up in a larch forest. The trees are sawn into manageable lengths for the sawmills and pulp or chipboard factories.

Their management poses quite different problems from those found in coniferous plantations. Most hardwood forests are managed to maintain the forest cover in perpetuity, at the same time producing a permanent and regular supply of timber. Little or no planting is done, and the stock of trees is maintained by natural seedlings. The result is woodland that contains trees of all ages and sizes. The problem for the forester is to keep the age classes in reasonable equilibrium. He does this by removing a portion of each age class whenever mature trees are felled for the market, thus opening the tree canopy sufficiently to allow a crop of natural seedlings to grow in the sunlight. A great deal of skill, patience and experience is required and if, as sometimes happens, there are no natural seedlings – oak and beech seed rather infrequently – the forester may have to plant groups of saplings to fill the gaps. As small sized hardwood timber is difficult to sell, the forester may plant conifers on the forest edges and in the larger gaps caused by wind blow or perhaps disease. These trees give an earlier return on some of the investment and provide protection for the sensitive young hardwoods.

Harvesting the crop The harvesting of the tree crop is a noisy end to decades of patient husbandry. Chain saws buzz and the trees come crashing down to be cut into manageable log lengths. Tractors grind slowly over the roughened, stump-ridden ground as they drag the logs to the ride-side where hydraulic grabs lift them on to huge lorries that carry them away to the sawmills and the pulp and chipboard factories.

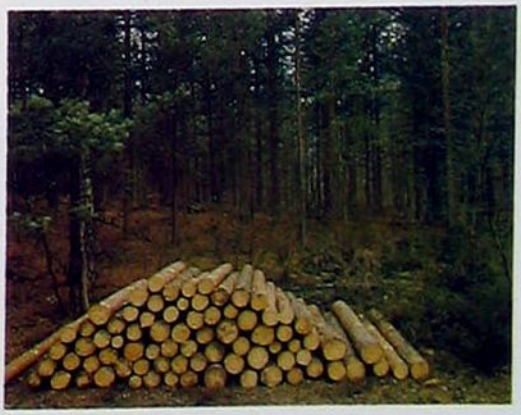
The problem for the forester is to predict the requirements of the timber trade in 60-100 years time, while at the same time growing an economically viable crop.

Above: A forest fire sweeping through a pine plantation. These fires are not only an economic disaster, they can be catastrophic to wildlife as well.

Right: A mature Scots pine tree being felled in the New Forest. This species is our only native pine tree. The valuable timber is used for telegraph poles, furniture, fencing posts and many other purposes.

The history of a Scots pine

phloem–soft tissue that conducts nutrients
narrow, sometimes uneven, rings suggest lack of water or attack by fungi, insects or disease
the sapwood conducts minerals and water from the ground to the living part of the trunk
bark protects the trunk
part of the trunk caught fire in its 22nd year
narrow rings suggest several years of poor, slow growth, and perhaps strong competition for light and food
in the early years the three grew well and steadily, suggesting that it had good growth conditions
apart from the fire, the tree had several years of steady, even growth, reflected in the wide, even rings



Above: Felled Scots pine trees. You can 'read' a cross section of one of the boles (left) for a detailed, accurate history of the tree in each year of its life. The width of the rings varies from one side of the trunk to another, reflecting exposure to varied conditions, such as continuous wind from one direction. Wide rings indicate rapid growth.

A WINTER WALK AT GRAFHAM WATER

The western creeks of Cambridgeshire's Grafham Water reservoir provide an exciting winter's day walk, visiting the nature reserve and its excellent birdwatching hide. Essential items of equipment are boots and warm clothing; and the rewards are so much the greater if you can bring binoculars.

Setting out on the path by the waterside, it is worth scanning the lake straight away for small parties of goldeneye. There may be a hundred or more of these diving ducks on the reservoir, though you may see only about a dozen. The male is distinctive, with a large, dark green head sporting a white cheek patch and a dark back that contrasts with white flanks. Towards late winter the males perform a display before the brown females, throwing back their heads and pointing their bills to the sky; this is a part of the process of pairing off, before the long flight to their northern breeding grounds.

Early morning is the best time to venture out along the reservoir edge. At this time of day you may come across mixed parties of small birds – chaffinches, greenfinches, yellowhammers, reed buntings and possibly bramblings. The whole party may settle briefly at the water's edge, or in the lee of a hedgerow where the birds feed on windblown seeds.

Beyond the hedges, the winter ploughed land is a settling place for flocks of feeding redwings – winter-visiting thrushes with the distinctive reddish patch on the flank and white stripe above the eye. They may be accompanied by fieldfares, which also migrate in from the north. If these two species are not in the open fields they can be seen feeding on hawthorn, or occasionally sloe.

Valley Creek is the first area of sheltered water that you come across and tufted duck often seek its calm, although even here they can be buffeted by the wind.

Coot are usually here too, with their near-black bodies and white bills and foreheads, consorting with drake and female mallard. Mute swans may have declined in number from their summer congregations, but nevertheless large groups can still be seen 'upending' with the duck, to fetch up what remains of the water weed and algae so late in the year.

Hedgerow path Leave the edge of the water by the willows and sallows in the corner of Valley Creek; the route proceeds slightly uphill beside the hedgerow. Here the hawthorn and sloe berries provide a valuable food supply for resident and winter-visiting thrushes. Other mixed flocks are present here – blue, great and long-tailed tits fuss their way through the bare branches and twigs, searching for insect larvae.

The bottom of the hedgerow is the home of many of our small mammals. In winter some hibernate but others, such as shrews, long-tailed field mice and voles, may be active.

Above: The view from the hide. Hundreds of waterfowl pack the shores of the reserve. In the two nature reserve creeks – divided by the spit of sand seen in the centre of the picture – boating, bank fishing and walking along the shore are all prohibited, giving an undisturbed area for wildlife.

Left: The harvest mouse will have left its ball-shaped breeding nest, which it occupies from June to September. In winter it is more active by day than by night, spending much of the time in an underground burrow, in which it makes a winter nest.

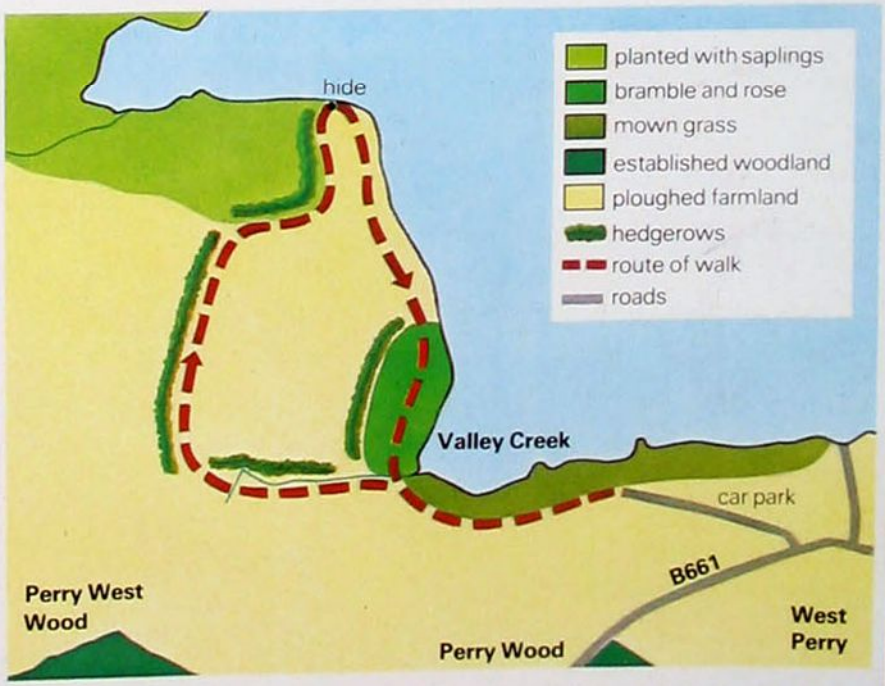
Sometimes it is possible to hear their soft, high-pitched squeaks coming from the leaf litter and matted vegetation: the common shrew can be particularly vocal. In winter it is the young that are heard, for the adults die at the end of the breeding season.

It has been said that hedgehogs may be heard snoring from hedgerows as they hibernate for the winter months. They curl up in leaves, grass and moss and would be difficult indeed to find: but do not try to find any, for if a hibernating creature is disturbed it can easily die–the amount of energy needed for it to awaken would probably leave its fat reserves dangerously low.

The path by the hedge is a favoured place for a hunting stoat or weasel. But both are unlikely to offer a long view–a quick look upstretched on hind legs, and then they are away to seek the protection of the trackside herbage. The stoat is the larger of the two, and close views reveal a black tip to the tail, while the weasel as it dashes across the track ahead of you looks exceedingly long and thin, almost like a snake. Hibernating rodents form a large part of the diets of these two predators.

At the top of the incline, turn right along the edge of the field. In the early morning you may notice rabbits playing on the open ground, and then disappearing into the bottom of the hedge as you approach. Perhaps you may be lucky enough to see a hare too or,

Grafham Water Reserve



This walk is best undertaken between September and March. Visitors can come any day of the week, but the hide is open only on Sunday, when a member of the Bedfordshire and Huntingdonshire Naturalists' Trust is usually present to give advice or help. Grafham Water is only 2 miles from the A1 trunk road and therefore acts as an enjoyable journey-break for travellers bound either for north or south. No public transport serves the area.

Above: A male chaffinch in the branches of an overgrown hedge. You may hear its call, a musical 'pink', and its rollicking song when it is not foraging with a bird party. The female is dull brown, but with white wing bars like the male.

in late winter, a pair of jack hares sparring with one another in competition for the does (females).

The lee of the hedge and field edges are good places to search for the few plants that flower during the winter, particularly as spring approaches. Lesser celandine begins to add a touch of colour to the winter path. Here too you may find some colonizing plants –shepherd's purse, chickweed, daisy and dandelion, along with red nettle and ground ivy.

Watching from the hide The path by the hedgerow brings you down to the nature reserve hide, which must be approached quietly. The hide overlooks two creeks where the greatest concentration of waterfowl gathers. On entering the hide you may find that the mass of birds before you–up to 2000 in number–is a daunting prospect if you are not used to identification. However, some you will already know–in Valley Creek you will have seen tufted duck, coot and mallard.

You may now see some noticeably different shaped birds, which often occur here in large numbers. The thin, white-fronted neck and pale, pointed bill, together with a dark, partially plumed crown, identify this as a great-crested grebe–quite different in its winter dress, having lost its chestnut and black plumes of summer. Another noticeably bright bird, clearly, by its shape, a duck, is the male pochard: it has a chestnut head, silver-grey body and black breast, while the female, as in most duck species, is a delicate shade of brown. The rather similarly coloured wigeon, which do not feed only in the water, can be seen on the north bank of the creek, where in most years the field is planted with winter wheat. Flocks of up to 800 wigeon come to take advantage of this easy source of worms and grubs.

Teal, the smallest of the British duck species, are often the most difficult to spot: they keep shyly to the shallow margins, though sometimes they can be seen feeding with the wigeon. The dramatic shoveler, with its incongruously large, battleship-grey bill, may appear in the floating groups (rafts) of birds in front of you, but in small numbers only.

Back to base Leaving the shelter of the hide, brave the elements once again to return along the edge of the reservoir. You pass through an area which has been planted with rose and bramble. This has been done because these plants provide an abundant supply of food for small birds. Thistles also grow here, and other plants with seed-heads that are frequented by goldfinches and redpolls.

Out over the deeper water, particularly in the late afternoon, a small party of goosander may appear. This large duck with pink-flushed white flanks and bottle-green head is, like the goldeneye, a winter visitor from the north. It is a fish-eating bird, and as dusk approaches parties return after spending the day on neighbouring gravel pits.

Fish are unlikely to be seen from the waterside during a winter walk, as they are much influenced by the cold. Being cold-blooded, they slow down their body processes in winter and therefore need less oxygen. So they are content to lie placidly on or near the bottom of the reservoir, conserving their strength.

As you approach the car park, take a look over the farmland to the south; here you should see partridges and pheasants feeding.

For those who return from the walk in the late afternoon, an enthralling last sight is the gathering of enormous rafts of gulls, up to 30,000 of them arriving from the surrounding farmland where they have spent the day feeding. Their noisy squabbling is a reminder of their presence well into the evening and brings to a close another winter's day on the reservoir.

Below: a flock of lapwings lifting off a field of winter cereals is a common sight in the neighbourhood of the reservoir, which is surrounded largely by arable farm land.

THE STRUGGLE FOR WINTER SURVIVAL

The unpredictability of our weather makes winter a hard time of year for all animals. The sudden falls of snow, heavy rain, frost, high winds and storms –and the occasional surprisingly warm day–tax the physical resources of the hardiest of mammals.

Above: There is not much to eat for a red deer hind and stag in the New Forest in winter. Shortage of food sometimes forces deer to move on to farmland to forage, where they often damage root crops and vegetables.

In winter mammals need to use more energy than usual to keep warm. But food is scarce and the daylight hours required for hunting are shorter; plants are lying dormant, not producing nourishing green shoots; and there are no flying insects about for the insect-eaters. Survival through to spring is achieved only by those mammals that are fit, strong and able to endure exposure to the cold and a shortage of food.

There are three ways in which mammals can solve this annual survival problem. The first is to move to more hospitable territory; the second is to hibernate–to sleep through the winter; the third is to fatten up in autumn, setting aside a standby larder when there is more than enough food about, and also to search harder for food. However, the inescapable fate of many British mammals in winter, especially of our smaller species, is death. They are simply unable to get through the months of food shortage and severe weather.

The long sleep Bats, like birds, have the necessary equipment for migration by flight, but they usually take a less strenuous course of action, going to sleep in winter. By the end of autumn, each bat has fed well on the flying insect population and has built up a thick layer of fat that almost completely covers its body under the skin. This fat provides the necessary energy for the bat's reduced metabolism (in hibernation it uses

about one hundredth of the oxygen it normally breathes). From October to April the bats congregate to roost. The greater horseshoe bat hibernates in caves or buildings, hanging upside down from wall or roof with its wings folded around it, while the pipistrelle prefers a sheltered dark place such as a barn or attic.

Bats are not complete hibernators, however; should the night air temperature reach 10°C (50°F) or more they may wake up from their torpor, and even fly around their winter quarters.

The long winter sleep of the dormouse may also be interrupted; then it will eat some of the store it has laid by in its nest. Like the bats, the dormouse becomes very fat in autumn; it settles in its winter nest (usually a burrow in the ground or a hole in a tree) and rolls up into a ball with its head bent down, chin resting on its stomach. Here it stays for six months. Its body temperature becomes so low that it feels cold to the touch.

The hedgehog is possibly the lightest sleeper of Britain's mammalian hibernators. It may sleep for only a few days at a time until well into winter. Then, from about December to March or April, it retires to the bottom of a hedge or a hollow under tree roots and curls up among the leaves, grasses and moss. Here it is secure from frosts until spring.

Squirrels are also able to live through short spells of severe weather in a lethargic state, but they do not hibernate. Heavy rain, mist and strong winds, rather than low temperatures, keep them in their dreys.

Above: The hibernating dormouse, supposedly secure and hidden among leaves and twigs, is not safe from foxes, or from badgers, weasels and stoats. Four out of five sleeping dormice may well be eaten each winter by hungry carnivores.

Below: A stoat in its white winter coat. Like foxes and weasels, this animal is out and about all winter, relying on its hunting skills to find food and its thick fur to keep warm.

Always on the move Most mammals live in the same territory or 'home range' all their lives, but the long journeys made by whales mean they live a settled life only at each end of their migrations. Some whales journey towards our temperate waters in winter. The common dolphin frequents the English Channel and is also found off the Irish coasts, coming from a south-westerly direction in autumn and leaving for the open Atlantic in the spring. The yearly migrations of shoals of mackerel and, off Cornwall, of pilchards may be a reason for the dolphin's movements.

For most whales, migration is linked to feeding and breeding needs. The fin-whale, or common rorqual, which can be seen at sea off our western coasts in spring and autumn, and the dumpy humpback whale, have similar feeding and breeding migratory habits. The Atlantic right whale, normally found in the north Atlantic, makes regular winter migrations to Spain, Portugal and North Africa, returning to the west of the Hebrides and further north in summer.

The seals, too, move round the coasts of Britain. The common seal, found all round our shores on sand and mud banks, moves away from the British mainland in winter. The larger grey seal, on the other hand, comes to our shores in winter to breed and bear young.

Seasonal struggle for survival For those mammals that do not migrate, or hibernate, successful survival through the cold months depends on a combination of factors. All mammals have coats of hair or fur which can be fluffed out in low temperatures to create an insulating layer of air and they can build up layers of fat beneath the skin during the summer which act as a shield against the cold climate ahead. Many mammals also hoard food as a precaution against the days when snow and rain make it impossible for them to forage and, to make fewer demands on their bodies, they slow down their pace of life in general.

The badger, for example, reduces its

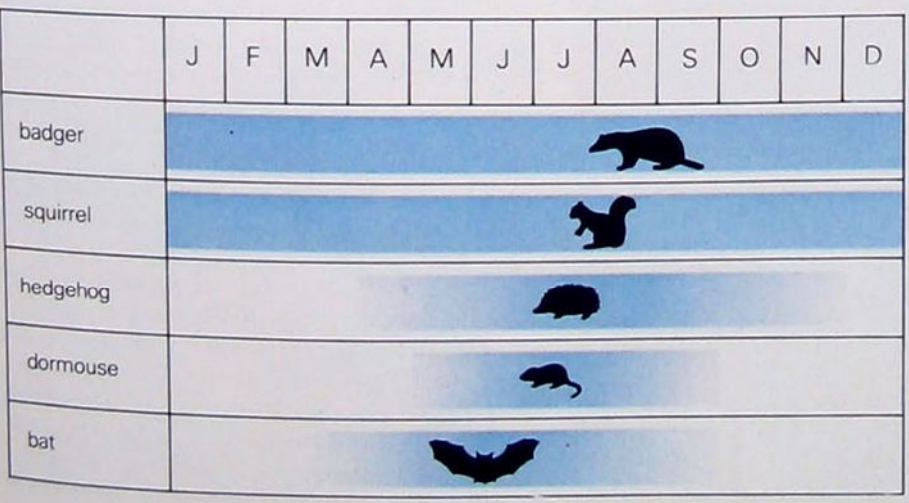
Above: Grey seals come to our stormy, rocky shores in winter, gathering in their breeding colonies on northern and western coasts from the Scilly Isles to the Farne Islands. Most of their pups are born between September and December.

activity in winter, spending more time in its sett. It can go without food for a fairly long time since much fat is stored under its skin, and it may remain below ground for several days at a time. However, even on the coldest days, some badgers are active. The fox is another mammal that is active all year round. A great opportunist, it readily comes into towns to scavenge. In autumn and early winter it is mainly active at dusk, whereas at the end of winter it may be about at any time of the day or night.

Fruits, berries and seeds are in great demand by many winter-active animals. Deer, essentially woodland dwellers, eat leaves, grass, berries, shoots and ferns, but also forage on farmland when times are hard. In winter red deer hinds and their families move down from the mountains in Scotland to lower ground where the land is more sheltered from wind and snow. The roe deer moves into denser parts of the woodlands and plantations during the cold months.

Plant seeds are an important food for the ground-feeders, such as the mice. The long-tailed wood mouse gathers seeds, berries and roots to set aside as a winter store in a side room or nest-chamber of its burrow. This mouse has been known to graze at night on winter cereals growing next to a wood, causing considerable crop damage in the process. The aggressive mole, whose whole life is a feverish hunt for food, also puts by stores for times of scarcity. To survive, it must consume its own weight of food every 24 hours. In winter, earthworms make up at least 90%, if not more, of its diet. After a sudden frost, when the movement of worms through the soil is restricted, the mole is able to eat its fill and still have enough to store. To do this, it injures the front end of each worm so that it cannot escape and then stores it in its 'fortress'.

Below: Not all mammals hibernate—the badger and the squirrel are active all year round. Those animals that do hibernate sleep for different lengths of time. Hedgehogs can still be seen in November and are active again in late March, while dormice hibernate in October and reappear at the end of April. Bats may wake up in late February.



The losers Many small mammals do not succeed in the struggle to live throughout the winter. Unable to escape from the cold, and without enough food to keep the body warm, they soon perish. The small muntjac, a fairly solitary deer of woodlands in central England, starves to death in severe seasons, while rats have a mortality rate of about 91–97% per year. High death rates occur among the shrews, mice, voles and rabbits as well.

Few small mammals ever survive more than one winter; because of this they are sometimes called 'annuals'. It is thought that the majority of adult shrews die in the autumn, leaving only the young animals to carry the species over the winter to the next breeding season. This means that each individual shrew lives about 14 to 16 months. It survives only one winter, that immediately after birth, and has only one breeding season, that of the year following its birth. The life history of mice and voles is very similar.

FISHERMEN'S FAVOURITE

The cod has been an important food fish in Britain for centuries. Its role today in the commercial fishing industry has made it one of the most sought-after fish in our seas.

Above: A small inshore cod trawler. The cod caught commercially today are smaller than those caught on lines in years gone by, because heavy fishing of our waters does not allow the cod to grow to any great age or size.

The cod is one of several abundant food fishes that are found on both sides of the North Atlantic. Along with the herring, mackerel, haddock and halibut it is the basis for an industry that has contributed greatly to the wealth of the Atlantic maritime states. It is a wide-ranging fish, as the distribution map shows. However, it is not evenly distributed throughout its range. In the Bay of Biscay it is a rare fish, and on the south coast of England, while not uncommon, it is far from being as abundant as it is in Scottish waters.

Winter and summer homes Migration plays an important role in the cod's distribution. The North Sea populations tend to move southwards with the approach of winter, so that more cod than usual are found on the Suffolk, Essex and Kent coasts in the winter months. A similar migration occurs on the west coast, causing cod that may have spent the summer off the north-west coast of Scotland and Ireland to appear in the western English channel during winter.

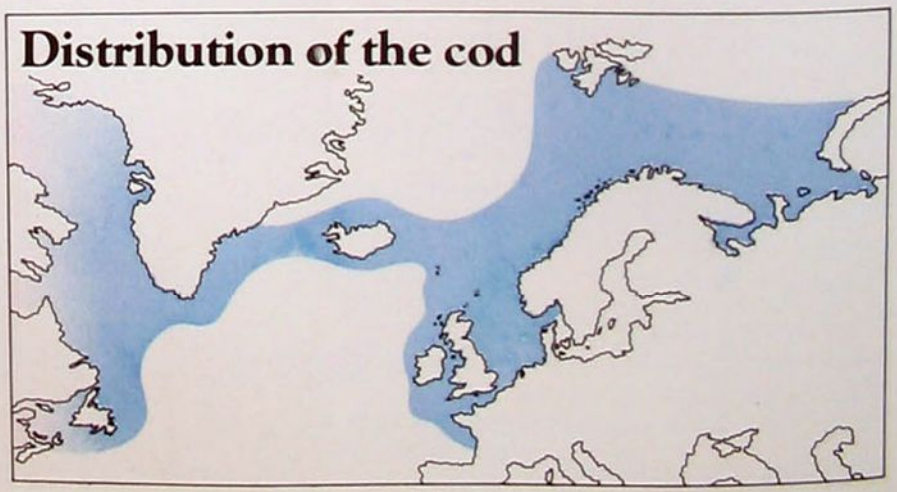
To some extent, these migrations are linked with the breeding season and also with the success of spawning. In the 1970s, a series of highly successful spawning years increased the number of cod in the North Sea considerably, and they spread to colonize areas where they are not usually seen.

Spawning migrations aroung the British Isles are usually northwards towards the cooler, deeper water, but on the Norwegian coast an immense migration occurs from the Arctic regions southwards to the Lofoten spawning grounds, which has made this region famous for its fishing industry. Such dramatic movements are not seen on British coasts; instead the fish migrate southwards in winter to feed, and northwards in early spring to spawn.

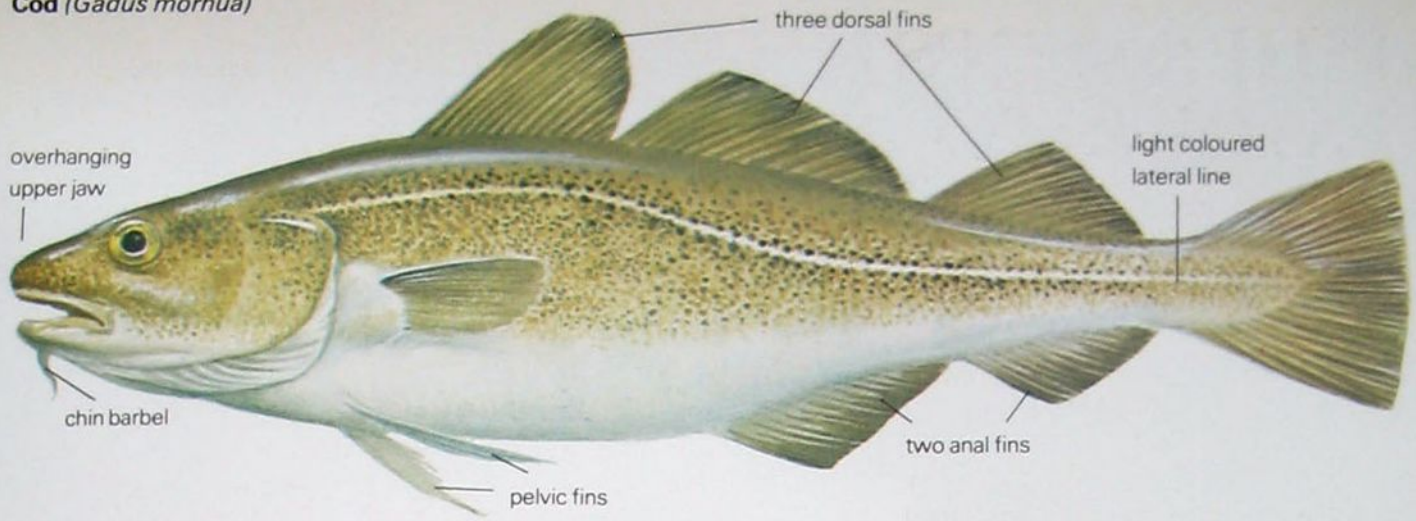
The spawning season In the North Sea, the main spawning period is from February to April and may even extend to May or later. The spawning grounds lie at a depth of around 100m (330ft) but as the eggs are slightly less dense than normal sea water, they rise towards the surface. They are very small–only 1–1·8mm in diameter–but they are produced in considerable numbers, possibly an average of one million eggs per female, although large fishes may produce many more.

The eggs require about nine days at 10°C (50°F) or seventeen days at 6°C (43°F) to hatch. The larva produced is about 4mm in length, the egg's yolk forming a prominent bulge on the underside. After the yolk is used up, the young fishes become progressively more pigmented, and from a size of about 20mm ($\frac{3}{4}$in) they have the tropical fins of a young cod. As they develop, their habitat changes slightly. From swarming at the surface in great numbers as newly hatched larvae, they drift with the currents into shal-

Below: The wide-ranging distribution of the cod, from Greenland south to the Bay of Biscay.



Cod *(Gadus morhua)*



lower water and then gradually disappear from the plankton to take up life near the sea bed at an age of perhaps two months, measuring about 2·5cm (1in) in length.

Growth rates vary from area to area but on average a year-old cod would be about 18cm (7in) long, at two years about 36cm (14½in) and at three about 55cm (22in). Before our seas were fished so heavily, huge cod of about 22·7 to 34kg (50 to 75lb) and of an estimated age of 25 to 40 years were frequently caught.

Greedy feeders The young cod feed almost entirely on the minute crustaceans called copepods. When they are older and living near the sea bed their diet is less restricted, but still includes copepods (although of different species) and other kinds of crustaceans, as well as worms.

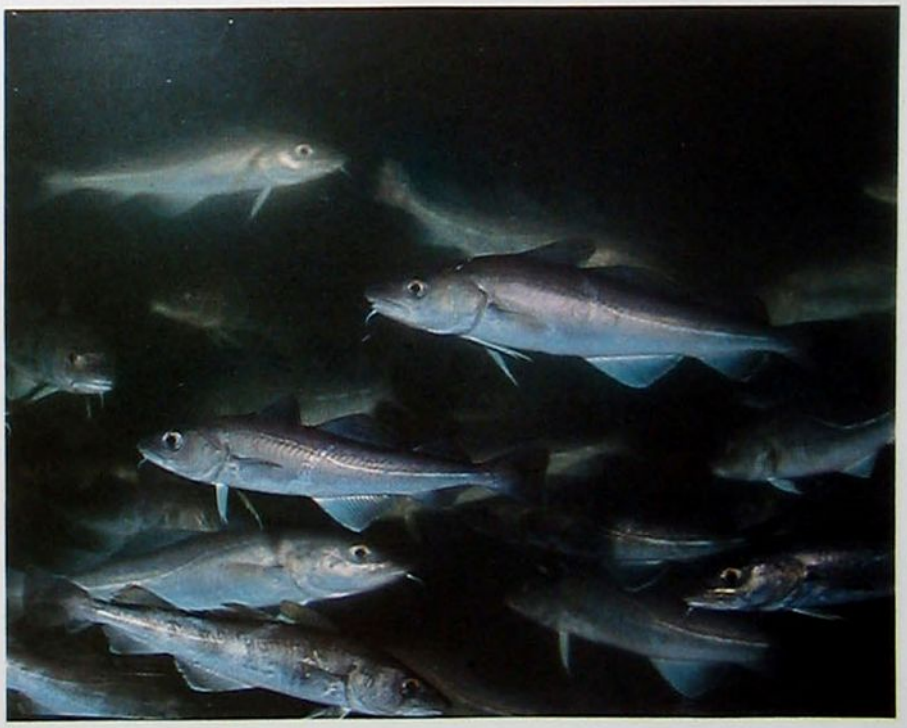
Adult cod have a very varied diet, which includes almost any animals living in numbers in its vicinity. Quantities of shell fish of various kinds, such as clams, razor shells, cockles and mussels are swallowed whole. Hermit crabs, lobsters, prawns and shrimps, brittle-stars, sea urchins and large numbers of lugworms and ragworms also form a part of the diet. More active prey such as squid and fishes of all kinds, but especially sprats, herring, flatfishes and small cod are commonly taken. The cod has a large appetite; in the winter of 1980–81, when sprats were extremely abundant on the North Sea coast, cod were stuffing themselves with them. Anglers found it difficult to catch the cod, but the stomachs of those fish that were caught sometimes contained up to 30 sprats. After eating so much, it was surprising that the cod still had the appetite to take the angler's bait!

Cod communication At night and in deep water individual fish keep in touch by sounds. Sound production is most noticeable as a preliminary to spawning and during the spawning season. The noises have been described as 'thumps' or 'growls' but they are in fact loud, low-frequency grunts, repeated three or four times. Noises are made by both sexes, for a variety of reasons, including warning off rival males before and during spawning, and attracting females towards the males. The noises are produced by contraction of the muscles that are attached at one end to the front ribs and to the swim bladder at the other. The swim bladder acts rather like a drum, amplifying the noises made by the muscles on its surface.

Camouflage colours Cod need camouflage to protect themselves from predators such as dolphins, seals and halibut. Those caught over sandy bottoms, on which they are most common, have pale yellowish-brown backs. Cod taken among seaweed in shallow water on northern coasts are dull green on the back, mottled with brown, while areas where the ground rocks have a reddish hue yield reddish-coloured cod. All, however, have a conspicuously light, creamy coloured, lateral line. So constant is the colouring of the fish that experienced fishermen can often judge where a fishing boat has made its catch by the colour of the cod on board.

Above: The cod, with its chin barbel, the wealth of sensory pores on the underside of the head and the sensitive pelvic fins, is ideally equipped for living and feeding close to the sea bed where, in shallow water, it is mostly found. However, it is equally at home in deeper water.

Below: In water of 61m (200ft) or more, cod form schools which usually swim some 30m (100ft) off the bottom. In daylight hours the school is compact, but with twilight, or in even deeper water, the fish tend to break up into a much looser school.



HOLLY: THE OTHER CHRISTMAS TREE

The holly is familiar to everybody as a popular Christmas decoration, with its brilliant berries and glossy, prickly leaves. In winter, these same features make the holly one of the most distinctive of our native trees.

The holly is found throughout the British Isles and is fairly common in most regions apart from the far north of Scotland and its outlying islands. It grows on a wide range of soils, provided they are not too wet, and is very tolerant of shade. This makes it ideal for woodland, its natural habitat, where it grows freely in the shade cast by taller trees. The holly is particularly common in oak-woods, where it may come to dominate other shrubs and small trees. It also springs up in thickets of scrub on commons and in hedge-rows.

Given enough time holly will grow to about 15m (50ft) tall, though it is usually encountered as a shrub 3–5m (10–15ft) in

height. In Britain, the tallest holly on record is a specimen 21·5m (71ft) high growing at Theydon Grove in Essex.

Hats and holms The New Forest in Hampshire is noted for its abundance of hollies and you can see many fine specimens growing there. On more open ground in the forest it forms pure clumps or groves. These are often circular in shape and are known locally as hats or holms. The word holm is an old name for holly and it still survives in place names such as Holmwood and Holmsdale, indicating that the tree is or was common in the neighbourhood.

Knobbly bark The trunk is covered with a pale grey bark which is smooth apart from scattered warts and blisters. On old trees the trunk becomes rather knobbly. This is caused by the bark growing over the scars left by the lower branches falling off as the tree grows. This pattern of growth gives older trees a dense pyramidal or rounded crown. Young trees, on the other hand, retain their branches close to the ground and their foliage forms a more conical crown.

In the days when there was a market for song-birds, holly bark was widely used to help trap them. A sticky paste known as 'bird lime' was made from the bark and other materials, and spread on to the twigs of a bush where a caged bird was hung as a decoy. The calls of this bird attracted others of its species and, as they alighted in the bush, their feet became glued to the spot, ready for the trapper to pick them off.

Glossy leaves It is impossible to confuse holly leaves with those of any other tree. They are rich dark green above and pale green underneath, basically oval in outline but with wavy margins extending at intervals into long sharp spines. The leaves have a leathery feel and their upper surface has a shiny varnished appearance due to the presence of a waxy waterproof coating called a cuticle.

Because the cuticle is waterproof it reduces greatly the amount of water lost through the leaves by evaporation. This helps the tree retain its foliage through the winter. At this time of year the roots of all trees have great difficulty in drawing enough water from the cold soil to replace that lost through the leaves. Deciduous trees overcome this simply by shedding their leaves in autumn, whereas evergreens such as the holly solve the problem by having a cuticle layer, so their leaves do not need to be discarded. However, even holly has been known to shed its leaves during an exceptionally severe winter.

The individual leaves persist on the tree for about two years, turning bright yellow and falling with the emergence of new foliage in May. The fresh young leaves unfurl from small round 2–3mm buds, alternately spaced along the green twigs. At first the young leaves are soft to the touch and pale bright green, sometimes flushed with a tinge of

Above: **Holly** (*Ilex aquifolium*). Evergreen, native, grows to 20m (65ft). Flowers May-July; Fruits November onwards.

Right: Holly seedling. Even the earliest tree leaves are spiny to discourage browsing animals.

Below: The trunk of an old holly tree is often knobbly where lower branches have been discarded.

purple. As they expand to their full size–about 7cm (3in) long–they turn dark glossy green and become spiny and stiff.

Prickles for defence The prickliness of the foliage discourages most, though not all, animals, from browsing off it. Horses, for example, are much less discouraged than deer from eating the leaves. Ponies in the New Forest seem to browse on holly with impunity, and older trees there have a distinct browse line marking the height to which the ponies can reach.

A curious feature of the holly is that when it reaches a height of about 3m (10ft), the upper branches–well out of the reach of browsing animals–produce leaves that are not spiny, except at the leaf-tip.

The toughness of the leaves makes them a formidable target for leaf-eating insects. One of the few successful ones is the caterpillar of a species of moth (*Stigmella aurella*). This mines tunnels and chambers inside the leaf, eating away at the soft inner tissue.

Flowers and fruits The holly has a long flowering season: about three months starting in May. Male and female flowers are borne on separate bushes, so a female bush without a male nearby will not produce any fruit.

After fertilisation the female flowers develop into small green fruits which ripen into the familiar bright red berries by late November. Each berry contains four seeds embedded in its pulpy flesh. These are dispersed in the droppings of birds, especially thrushes, fieldfares and redwings. In a severe winter birds can rapidly strip a holly bush bare, though in normal conditions the berries are likely to be left until more palatable fruits have been eaten.

Wood for burning Freshly cut holly is an excellent firewood since it burns fiercely without the need for seasoning. However, this also means that it suffers badly in bush and heath fires, especially as the foliage bursts into flames so easily; this is due to the oils that make up the cuticle and which produce an inflammable vapour when heated.

Above: Both flowers and berries are found clustered around twigs near the base of the leaf-stalks.

Right: Male and female flowers are very similar. Each is about 5mm across and consists of four rounded, white or slightly pink petals and four yellow-green stamens or stigmas, depending on whether the flower is male or female, respectively. The flowers shown here are male.

Below: Male and female flowers are borne on separate trees. From a distance, trees of different sex look much the same, unless the female is bearing fruit. Here, the female tree is on the left, with a male on the right.

Holly timber is almost white, fine-grained and hard. It has been employed for turning small decorative pieces, for inlaid work and carving. It was also dyed black and used as a substitute for ebony.

Numerous decorative varieties of holly have been bred for the garden. Some have white or yellow berries, others variegated leaves, and there is even one variety, called Hedgehog, which grows spines on the leaf surface as well as round the edges!

Folklore There is an old superstition concerning holly and Christmas that was commonly held to be true in many parts of the country. The belief was that if you wrapped nine holly leaves in a handkerchief tied with nine knots and placed this under your pillow on Christmas night, then you would dream of the person you were destined to marry.

DWELLERS IN DARKNESS

Centipedes and millipedes – multi-legged arthropods that abhor direct sunlight – belong to a twilight world whose denizens are seen only when their homes in soil or leaf litter are rudely disturbed.

Direct sunlight is hostile to centipedes and millipedes, hence these animals are to be found in a variety of moist, shady environments – deep in the soil for instance, in leaf litter, or beneath peeling tree bark. Some also occur in shoreline habitats, and a few species live as tolerated 'guests' in the nests of ants.

Some common centipedes Of the 44 species of centipede in the British Isles – 12 of which are aliens – probably the most familiar are the rather flat-bodied lithobiids, typified by the common, shiny, dark or reddish brown *Lithobius forficatus* that frequents gardens and woodland. *L. duboscqui* is another fairly common but much smaller and slimmer garden centipede. One of the most interesting in the group is *L. variegatus* which, while widely distributed in the British Isles, is found nowhere else in the world.

By contrast with the lithobiids, the more delicately built, many-legged geophilid centipedes are subterranean in habit, their thin flexible bodies allowing negotiation of the smallest crevices. *Necrophloeophagus longicornis* is one common species, and another is *Haplophilus subterraneus*.

Less well-known are Britain's only representatives of the Scolopendridae, tropical species of which can attain a huge size and possess a dangerous bite (all British centipedes are harmless to man, although *Scutigera* has a bite that is as severe as a wasp sting). *Cryptops hortensis* is one of three species that sometimes occur in gardens.

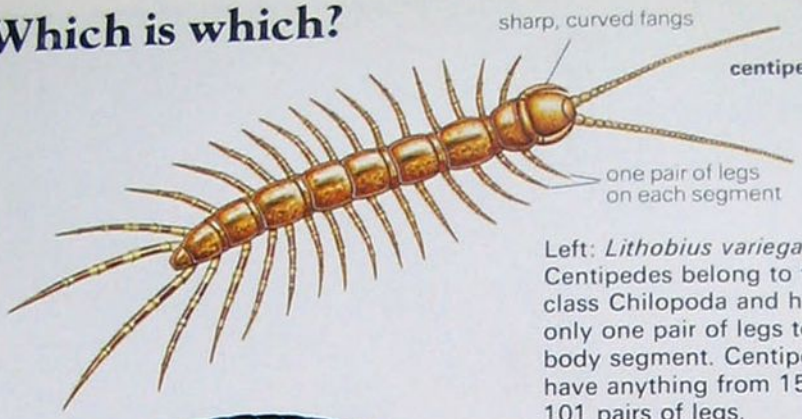
Many types of millipedes The most familiar of the British millipedes – there are about 50 species – are the so-called snake, or julid, millipedes. These are typified by the shiny, blackish *Cylindroiulus londinensis* and the very similar *Tachypodoiulus niger*. Equally common, but rather smaller, is *Blaniulus guttulatus*.

Another group, the polydesmids, have flattish body segments that are often beautifully sculptured and embossed. Equally distinctive are the curious pill millipedes, of which *Glomeris marginata* is the commoner of the two species, occurring especially on chalky soils in open woodlands in southern England. By contrast with these groups, the tiny aberrant millipede (*Polyxenus lagurus*) is rarely seen on account of its minute size – 2–3mm. Most frequently discovered in the bark of various trees, notably willows, it also occurs as a scavenger in the nests of wood ants where its bristly body probably deters attack.

Above: *Lithobius forficatus*, a 3cm (1¼in) long centipede; found in leaf litter and beneath rotting timber.

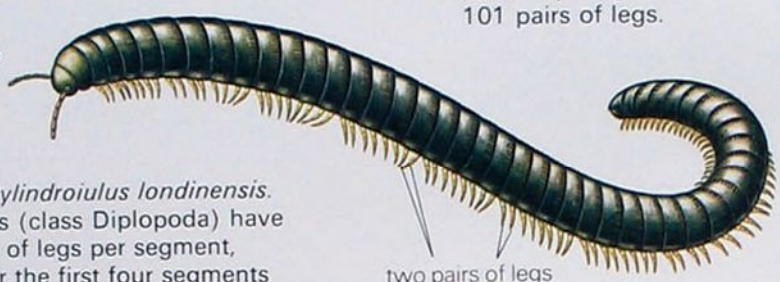
Below: The millipede *Tachypodoiulus niger*, 2·5-3cm (1-1¼in) long.

Which is which?

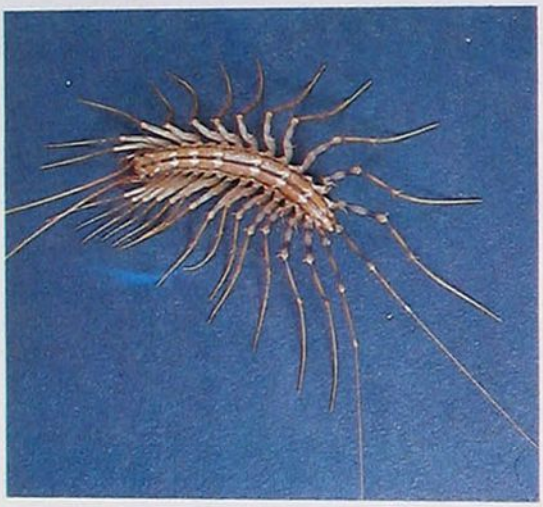


Left: *Lithobius variegatus*. Centipedes belong to the class Chilopoda and have only one pair of legs to each body segment. Centipedes have anything from 15 to 101 pairs of legs.

millipede



Above: *Cylindroiulus londinensis*. Millipedes (class Diplopoda) have two pairs of legs per segment, except for the first four segments (one pair) and some limbless segments at the end.



Left: *Scutigera coleoptrata*, a centipede with extremely long legs, is the only British representative of its group, the Scutigeromorphidae. The hind pair of legs probably act as extra antennae. Moderately common in the Channel Islands, it occurs only sporadically on mainland Britain, and then usually in buildings.

Below: *Haplophilus subterraneus* is a 7cm (2¾in) long centipede that is common in grasslands.

Carnivores and herbivores Centipedes are predominantly carnivorous, possessing sharp-pointed fangs that follow the curvature of the head and are in fact forelegs specially adapted for piercing and injecting prey with poison. They prey on a wide variety of invertebrates, including insects, spiders, earthworms and snails. The victim is sought out by scent and touch, via the centipede's antennae and body hairs, and is seized and passed back from the claws to be chewed up by the mandibles (although geophilids usually first secure their prey in their coils, rather after the fashion of a constricting snake). Some geophilids consume vegetable matter, notably *Haplophilus subterraneus* which occasionally attacks root crops.

While the larger snake millipedes sometimes prey on soft-bodied insect larvae, and also scavenge on dead animals, most millipedes eat decaying vegetable material. *Blaniulus guttulatus* can sometimes be found feeding in potato tubers, but it is doubtful if it makes the initial inroad since its mouthparts are relatively weak. Such attacks usually occur in dry weather, suggesting that the primary objective is moisture. This may also be true of various polydesmids, such as *Oxidus gracilis*, which frequently eats fruits.

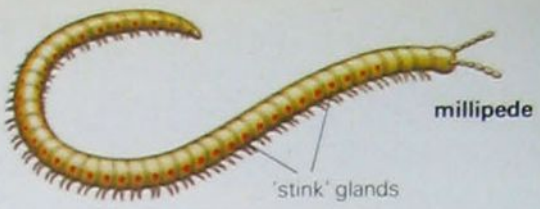
Moisture a must Moisture is, in fact, an optimum requirement for both centipedes and millipedes, since both have a rather inefficient means of conserving body moisture. In most cases their skin (cuticle) lacks the waxy waterproof layer typical of insects, so that they die within a few hours of exposure to dry air and sunlight. Drought or very cold weather prompts a retreat deep into the soil, and even in normal conditions the animals instinctively seek situations where they can lie up with both body surfaces in contact with soil, leaves or bark.

The aversion to light (negative phototropism) is further indicated by the absence of eyes in most millipedes as well as in geophilid and scolopendrid centipedes. The more surface-active, though basically nocturnal, lithobiids have groups of simple eyes (ocelli) on each side of the head, but they probably do no more than register degrees of brightness. An exception to the rule is *Scutigera*. Because it is active in the daytime (diurnal) or at twilight (crepuscular), it has excellent vision and a more efficient respiratory system than other centipedes.

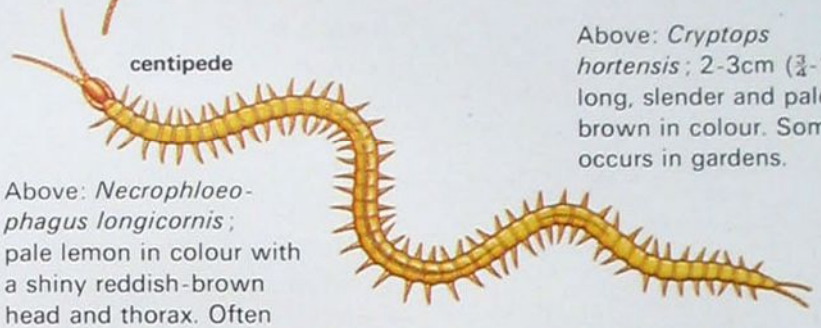
Rapid runners Centipedes are extremely rapid runners. High-speed photography indicates that, in lithobiids, the limbs move alternately in groups on each side of the body, some limbs being off the ground at each stage in the animal's progress. Each leg is slightly longer than the one preceding it, which makes for more efficient locomotion. As the rapidity of movement increases, fewer limbs are in contact with the ground, while still faster movement is achieved by raising the body right off the ground. This effect is particularly

Above: *Polydesmus angustus*; differs in having flattish body segments clearly separated and 'winged' at the sides.

Right: The spotted snake millipede *Blaniulus guttulatus*; pale greyish brown in colour, with a line of red spots low down on each flank.



Above: *Cryptops hortensis*; 2-3cm (¾-1in) long, slender and pale brown in colour. Sometimes occurs in gardens.



Above: *Necrophloeophagus longicornis*; pale lemon in colour with a shiny reddish-brown head and thorax. Often found in the soil.

evident in *Scutigera*, whose 15 pairs of exceedingly long legs enable it to move at speeds of 50cm (20in) per second.

Millipede locomotion is slower and more deliberate; these creatures have a greater number of legs always in contact with the ground, thus longer forward and backward strokes are produced. A rippling wave movement, as one leg follows another is particularly evident in julid millipedes, each whitish leg being slightly out of step with the one before it.

Defensive tactics Rapid running when exposed to view is probably a centipede's sole defence against larger predators such as insectivorous birds, mammals and amphibians. Cannibalism is not uncommon among centipedes, and it is likely that this occurs during skin moults when the young are especially vulnerable.

Millipedes use more positive defences; for example, they exude a repellant acidic gas from stink glands along the sides of their bodies, or they roll up into a flat ball, as in julid millipedes, or into a complete ball, as in *Glomeris*.

Mating and caring for young Reproduction in centipedes and millipedes is similar in some respects. In centipedes, fertilisation of the eggs takes place by means of a spermatophore, or sperm packet, which the male deposits on a silk web. This packet is then taken up by the female in the reproductory appendages at the end of her body. In most millipedes, however, actual copulation occurs.

Eggs are generally laid in the soil, or perhaps between layers of bark. Lithobiid centipedes deposit their eggs singly, first covering them with a glutinous secretion to which camouflaging particles of soil adhere. They are then abandoned to their fate, the young centipedes being active and independent from the moment they hatch.

Geophilids, however, display a greater degree of maternal care, coiling round a batch of about 30 or 40 eggs laid in a cavity in the soil, or in rotting timber, and protecting the young until after their second cuticle moult. Polydesmid millipedes, too, stay with their young for a time.

Above: The pill millipede *Glomeris marginata* can roll up into a ball, and then resembles the pill woodlouse *Armadillidium*.

Right: *Tachypodoiulus albipes* has a 'rippling' leg movement and can curl up into a flat ball. Like other snake millipedes, it is expert at climbing smooth surfaces.

The lifespan of centipedes and millipedes is difficult to ascertain, but some live for five to seven years.

NATURE'S OLDEST ROCK-STARS

Surviving in conditions where other plants would quickly perish, tenacious lichens can be found growing on wave-battered cliffs and exposed mountain ledges.

The familiar coloured patches that encrust the surfaces of rock and stonework and often seem like an integral part of their growing surface are lichens. They are sometimes known as 'time-stains' as they are often found on ancient monuments, churches and tombstones, where they are frequently nearly as old as their habitat. There are in fact about 1400 species of lichen in Britain, although only about 500 of them are relatively common.

Because of their structure–a combination between an alga and a fungus, existing in a symbiotic relationship–lichens are able to withstand long periods of drought that would be fatal to other plants. It is this that allows them to grow on bare rock faces where little else can survive. One of the reasons why lichens are such a successful group of plants is their ability to colonise such areas, and also to withstand harsh conditions such as extended drought.

However, they are vulnerable to atmospheric pollution because they absorb water over their whole surface. As they have no roots through which to filter it, absorption is indiscriminate and pollutants dissolved in the water can build up, eventually killing the plant. Therefore, many species are to be found away from urban areas, particularly on the coast and in the mountains, where the air is cleaner.

Lichen bands Coastal lichens can be seen at their best on sea cliffs where they form well defined communities according to the degree of their exposure to salt water, giving the cliff a characteristic banded appearance. The lowest of these bands or zones extends from well below the high tide mark. It tends to be black in colour, due to the presence of innumerable thalli (thallus is the name given to the main body of the lichen) of the tar lichen *Verrucaria maura*, although other species may also occur. Covering the surface of the rock with a black gelatinous coating, the tar lichen is well named as, from a distance, large areas of it may look like patches of oil or tar.

Above this zone, but still within reach of the salt spray, is a narrower band of orange

Above: A rocky cliff at low tide, clearly showing the zones or bands of vegetation. At the high water mark at the bottom of the cliff, blue-green seaweeds such as channelled wrack–which becomes black when it dries out–merge with the tar lichen *Verrucaria maura*. A little higher, out of reach of the waves, the orange and yellow lichens such as *Caloplaca thallincola* and *Xanthoria parietina* appear. *Xanthoria* thrives particularly well near salt sea spray, as well as on walls and roofs inland. Further up the cliff, the grey encrustations of the *Lecanora* species of lichen appear, giving way to the grasses, flowering plants and trees that form the vegetation on the cliff top.

crustose lichens. The species most commonly seen are the orange sea star (*Caloplaca thallincola*) and the orange sea lichen (*Caloplaca marina*). The thallus of the orange sea star is drawn out into projecting lobes that form parallel lines radiating from the centre of the rosette-like thallus, while that of the orange sea lichen consists of irregular granules with distinct spore producing discs.

Out of reach of the waves is a grey-green zone composed of a greater variety of species, including some also found inland. It is here that foliose (leafy) lichens appear. One of these, the narrow-lobed rock lichen (*Anaptychia fusca*) can occasionally be found growing on walls inland. The thick, flat, brown finger-like lobes extend out from the centre of the thallus and often form large rosettes which are loosely attached to the rocks. It may appear green in colour when wet.

Coastal species are not confined only to the cliff face. A handsome bushy species found above high tide mark on the sea shore is the sea ivory (*Ramalina siliquosa*). It has greenish-grey brittle tufts with a noticeably shiny lustre which sprout from among the rocks, or hang down in clumps.

Mountain lichens Although mountain species may grow on very similar ground, the variations in altitude are obviously much greater and this can have important consequences in determining the species present. The black crottle (*Parmelia omphalodes*), which is more of a metallic brown colour than black, is a very common lichen found loosely attached to rocks at high altitudes. At lower altitudes it is replaced by the bluish-green common crottle (*Parmelia saxatalis*), which often grows on trees as well as on rocks and walls. It grows in circular patches and develops a green tinge when wet. A strange piece of folklore associated with this species held that it possessed magical powers if gathered from the mouldering bones of a human corpse!

Another mountain species is the red-eye lichen (*Haematomma ventosum*), which takes its name from the large, blood-red, disc-shaped fruiting bodies that cover the yellowy-green thallus. At one time, the lichen was scraped off the exposed, well lit rock faces on which it prefers to grow, to be used to make a reddish-brown dye.

The rock tripes which, as their name suggests, bear a resemblance to tripe, are an unusual group of mountain lichens, in that they are attached to the rock only at one central point. The fringed rock tripe (*Umbilicaria cylindrica*), is a greyish coloured species with lobes edged in a fringe of rigid black hair around a pale centre.

The Iceland moss (*Cetraria islandica*), is common in the north of England and Scotland, often growing among heather and other vegetation. In spite of its popular name, it is in fact a lichen, the dark brown forked and spiny fronds looking little like a moss.

Right: *Verrucaria mucosa* is found on rocks on the sea shore. It tends to appear in patches rather than forming the extensive areas covered by *Verrucaria maura* (opposite), but it still bears a resemblance to splodges of tar or oil.

Below: *Haematomma ventosum* is an attractive and conspicuous lichen that encrusts rocks and boulders in mountainous areas. It is yellowy-green or grey in colour, spotted with the blood-red discs that give it its name (*haema* being Greek for blood).

Left: The intricate patterns of the map lichen (*Rhizocarpon geographicum*) appear on hard acid rocks in both mountain and coastal areas. It has a distinctive appearance, with a bright yellow thallus that grows over a black underlayer. This is visible through cracks in the surface and around the edge, and gives the lichen the appearance of a map when it grows in large patches.

MASTER NEST BUILDERS

The long-tailed tit is quite distinct from other British tits, not only in appearance but also in its habits, most spectacularly in the elaborate oval nests it builds.

The long-tailed tit is a minute black, white and pink bird. Without its 8cm (3in) tail it would be by far the smallest of the British tits, with a body length of only 6cm (2½in).

When the population is high long-tailed tits can be found in any habitat, provided it has trees or shrubs, and they even appear regularly in suburban gardens. When their numbers are low, however, they tend to stay in their favourite habitats: scrubby woodland and farmland with mature hedges.

Although their common name places them with the tits, they are in fact members of a different though closely related group of birds. True tits nest in holes in trees (or in nest boxes), whereas long-tailed tits build one of the most amazing nests of any bird. Another reason for classifying them differently is that true tits stay in small family groups. Long-tailed tits, on the other hand, are almost always seen in flocks, no matter what the time of year.

Flocking together The size of the flocks may be as small as three or four members, or it may contain more than 20, particularly just after the breeding season.

During the autumn and winter the members of the flock stay together all the time, and can be heard calling to each other continually. At this time of year the flock defends a small territory, just a few hundred metres across. The edges of each flock's territory may overlap into those of other flocks, but the different flocks would not feed there at the same time. Instead, one or the other would give way.

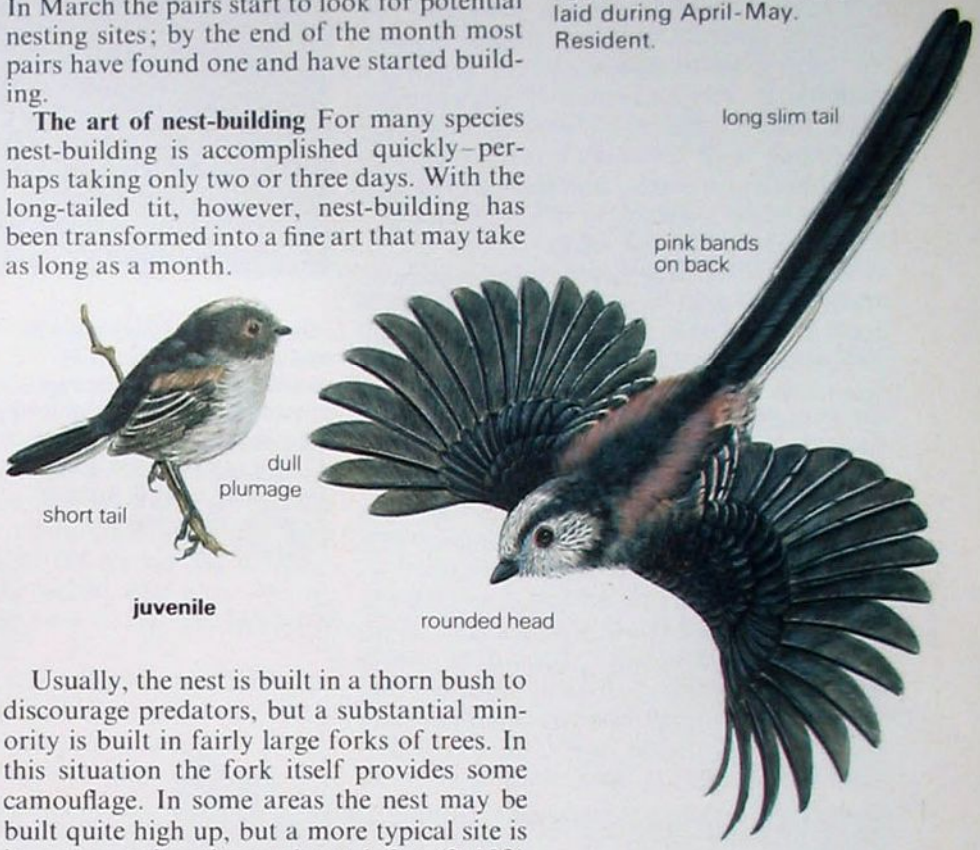
The flocks contain both young and old birds, and males and females. Not much interchange of members takes place between flocks; what there is consists of young females on the move.

Long-distance flock movements have sometimes been recorded. The record in Britain is held by two birds that were marked at Great Yarmouth, then found in Dorset, 340km away, only 15 days later. On two occasions small flocks have been recorded flying over 100km. All these long-distance movements have taken place in October.

After staying together throughout the winter, the flock starts to divide up into breeding groups with the onset of warmer weather. This can be as early as mid-February. Usually these small groups consist of male and female pairs. The flock re-assembles each evening about half an hour before roosting. In March the pairs start to look for potential nesting sites; by the end of the month most pairs have found one and have started building.

The art of nest-building For many species nest-building is accomplished quickly – perhaps taking only two or three days. With the long-tailed tit, however, nest-building has been transformed into a fine art that may take as long as a month.

Long-tailed tit (*Aegithalos caudatus*). Length 14cm (5½in). Found in the fringes of woodland and scrubs, waste land and hedgerows. 8–12 white eggs speckled pale red are laid during April-May. Resident.



Usually, the nest is built in a thorn bush to discourage predators, but a substantial minority is built in fairly large forks of trees. In this situation the fork itself provides some camouflage. In some areas the nest may be built quite high up, but a more typical site is in gorse or hawthorn about 1–3m (3–10ft) above the ground.

Both partners help in the building. First, they bring moss, spider's webs and hair to build the base of the nest. Then they continue to add material, working from the inside to weave a complete oval shell, apart from a small entrance towards the top.

Next, they cover the outside with lichen. The nest now looks rather like an old-fashioned blown glass bottle. Indeed, one of the many country names for this tit is the bottle tit.

Finally, the birds line the inside of their nest with a prodigious number of feathers.

Below: Long-tailed tits are unusual in that most breeding pairs are helped by others of the species to feed their young. Usually, but not always, helper birds belong to the same flock as the parents.

Some nests have been found to contain more than 2000. This final touch ensures that the nest is superbly well insulated to keep the eggs and young warm. Small birds such as the long-tailed tit lose heat very easily, and so a well-insulated nest is very important.

Eggs and young Egg-laying generally starts in the first half of April in southern England; in colder parts of the country this happens a little later. A typical clutch is between eight and twelve eggs, but large numbers are frequently lost to predators such as jays, magpies and weasels, and the parents may have to build a new nest. This can delay egg-laying until the end of May.

If a pair of long-tailed tits do have to build a new nest, they do it much faster the second time round, and the nest is not so well constructed. This may be because the birds are under pressure to breed as early as possible, though it has also been suggested that, as the weather warms up, the need for good insulation becomes less urgent.

On a few occasions egg-laying has been recorded as late as July or even August. This seems to indicate that long-tailed tits may produce a second brood, though very rarely.

A helping hand The eggs hatch after about 16 days. During the early stages in the growth of the young the long-tailed tit displays a very odd pattern of behaviour: breeding pairs are often helped by other long-tailed tits to feed their young. During the last few years it has been discovered that helpers are frequent among tropical birds, but very few examples have been discovered in this country.

Above: Long-tailed tits can often be seen in flocks working their way through the trees and bushes in their territory searching for food. Flocks can range in size from three or four up to 20 or more, depending on the time of year.

This strange phenomenon was examined in a detailed study carried out near Oxford. Of the ten pairs of birds that were followed closely, eight were helped at some stage during the first seven days of the young chicks' life.

Once the young have fledged the individual family flocks join up with others in the same group territory. But if some pairs have been forced by predators to build a second nest, then their young are still unfledged. When this happens, the group territories probably alter as these less advanced families switch to another group.

Fledgling to adult At first, the young fledglings have a rather drab plumage and do not look at all like their parents. In particular, the tail is shorter. Then, during early July, long-tailed tits exhibit another unusual characteristic. At this time of year, both adults and fledglings start to moult. But, unlike fledglings of most British birds, which replace only their body feathers, the fledglings of long-tailed tits exhibit another unusual char- feathers as well.

The moult takes three months or more, and when completed young and old are no longer distinguishable. By then it is October, when the flocks may undertake long-distance movements. Once November arrives, the flocks are usually settled in their territories ready for the winter.

Surviving the winter Small birds such as long-tailed tits are particularly vulnerable in the winter because they lose heat so easily. The days are short, and so there is little time to search for food, which in any case is often in short supply. As the weather becomes colder, insects (their staple diet) become less active and are harder to find.

In a harsh winter as many as 90% of the autumn's population of long-tailed tits may not survive until the spring. But, with the large number of eggs that they lay, these birds are well able to replenish their numbers. They soon return, even to areas where all the resident birds have perished.

Right: In winter, groups of long-tailed tits can be seen roosting huddled up together to keep warm. Being so small they lose heat very quickly on their own, and in winter need extra food to keep warm. But their staple diet of insects and spiders is often in short supply at that time of year, so little tricks such as this can mean the difference between life and death.

Mortality in birds

Long-tailed tits, along with most other birds, suffer a much higher mortality rate than most people realize. For example, among blackbirds only one chick in 50 will reach its seventh birthday. Compare this figure with the mortality rate for people in the developed world, where a baby has an even chance of reaching the same equivalent age of 70.

There are several reasons for this. A young bird develops quickly and is soon abandoned by its parents to look after itself. It has many more hazards to face than humans: it may be killed by a cat, eaten by an owl or fly into electric wires. It may starve to death if it cannot feed itself efficiently, and if the parents die before breeding then a whole generation of birds is effectively wiped out.

Bird populations are able to survive only because the number of young produced in the breeding season is enough to make good these losses and ensure the survival of the species.

ANCIENT FORESTS OF SCOTLAND

The Caledonian pinewoods are places of great beauty, an essential part of the magnificent scenery of lakes and rivers, slopes and mountains that make the Scottish Highlands world-famous. Today they are prized as a natural habitat.

Below: Benn Eighe National Nature Reserve, with remnants of the old forest. This is a fine example of Scotland's Highland scenery, clad in pinewoods and never far from water – in this case Loch Maree. The tree that we in Britain know as Scots pine grows as a native species in more countries than any other conifer. It extends from the Atlantic to the Pacific and from the Arctic to southern Spain, where it occurs up to 2000m (8000ft) above sea level.

Pinewoods are a common sight in many parts of Britain. Some are on the uplands of Wales and the north and west of England; others are in the English lowlands – in parts of Surrey for instance. Most of these are plantations, as you can see by the fact that the trees grow in straight rows and are all the same age. They stand close together, their branches meeting to form a canopy so dense that no flowering plants can grow below. Instead the woodland floor is a bare soft layer of brown needles.

The genuinely wild pinewoods of Scotland are altogether different. There the trees occur in patches of different ages and sizes, sometimes including veterans up to 300 years old. The trees themselves are varied in form, from the usual conifer shape with slanting branches to those with widely spreading crowns. Some are grouped closely; others are spaced by open, sunny glades.

With a few exceptions, the Caledonian pines are rooted in relatively infertile, limeless soils, consisting mostly of coarse sands and gravels of glacial origin, formed from the ancient rocks of the Scottish Highlands. Because of the poor soils, the pinewoods have a ground cover almost entirely of calcifuges (lime-avoiding plants) such as mosses, bilberry, heather and crowberry. These grow in such thick carpets that only a few other species can get a root in anywhere. Those that succeed include such vigorous, thrusting plants as the small yellow-flowered tormentil, the white-flowered fragrant heath bedstraw and the elegant wavy hairgrass.

Attractive flowers Here and there amid all these common plants of the pinewoods are a handful of attractive wild flowers that are always an interesting find: some of these are rare in Britain. There is the twinflower, named *Linnaea* after the pioneer Swedish botanist, Linnaeus. It creeps shyly over the woodland floor and bears small, drooping flowers in pairs. With it may be found the coralroot orchid, which is yellowish (having no chlorophyll) and feeds on rotting vegetation as does a fungus. Two other orchids are also to be found: creeping lady's tresses, which has a

Above: The pine marten, after the intense persecution it suffered at the hands of gamekeepers last century, is still rare, but is steadily regaining ground.

Right: Twinflower is rare, elegant and small: it does not exceed a height of 7cm (3in).

neat spiral of tiny white flowers; and the lesser twayblade, which has reddish spikes and often hides under heather.

Then there are five wintergreens: the one-flowered, the greater, the round-leaved, the common and the serrated: they have lovely waxen white flowers and are scattered sparsely through the pinewoods. Another beautiful wild flower, the chickweed wintergreen, is badly named because it belongs to the primrose family. The leaves are dainty and the flower usually has between five and nine white petals. This plant is much commoner than many of the true wintergreens.

Like those of most trees, the root-tips of the pine live in intimate association with fungi; in the Scottish woods about 30 species of fungi are known to have evolved this mycorrhizal way of life which benefits both tree and fungus. Several kinds of boletus and also the white-spotted, bright red fly agaric are known to live in association with pine roots. Several bracket fungi are not so helpful to the trees: they can, in fact, be totally destructive, two well-known ones being *Phaeolus schweinitzii* (formerly *Polyporus*) and *Heterobasidion annosum* (formerly *Fomes*).

Pests that do no harm Compared with oakwoods, pinewoods and conifer forests in general are poor in insect life. However, they do contain several species, particularly of beetles, that in Britain are known only from the native pinewoods. In addition several species of spider are known only from these woods. A number of insect species, which are regarded as pests when they occur in plantations, also live in the Caledonian forest, where they generally play an unassuming part in the natural ecosystem. For example, caterpillars of the pine beauty moth, a moth well camouflaged when clinging to the red bark of pine, seldom seem to cause much damage in the natural pinewoods but can devastate neighbouring plantations of lodgepole pine.

Bird life Among the birds that breed commonly in the Caledonian forest are siskin, chaffinch, goldcrest, tree pipit, wood warbler, willow warbler, spotted flycatcher and redstart. They are all species widespread in Britain; but there are three birds that belong much more intimately to the Caledonian pinewoods: crossbill, crested tit and capercaillie. The crossbills breed early in the year, usually in late March but occasionally in February. Their nests are notoriously hard to find, often being high up in the pines and out on a side branch. For food crossbills depend heavily on pine seeds, in search of which they wander about in flocks – these are at their largest just after the nesting season.

Above: A male capercaillie performing his remarkable display. With his tail spread wide and beard thrust forth, he threatens any intruder with ferocious sounds, occasionally leaping from the ground in apparent fury.

Like the crossbill, the crested tit has probably dwelt in the Caledonian forest for thousands of years. But unlike the crossbill, whose numbers are occasionally increased by immigrant invasions, the crested tit is a

Right: Abernethy Forest, an original pinewood which shows a typical interior, with bilberry and heather.

sedentary species which may have existed in isolation in Scotland over a long period. If so, then four centuries of felling of the ancient forest must have reduced its numbers enormously. Happily it has spread in recent years to pine plantations elsewhere. But it is still a rare bird.

The tremendous devastation of the old forest proved too much for that outsize gamebird, the capercaillie, and somewhere around 1760 it died out altogether. Three-quarters of a century later it was reintroduced from Sweden; it was able to survive in the new plantations that were then growing up and providing new cover, and the bird is now widespread. Another success is that of the osprey, which also vanished for many years. But it did not wait to be reintroduced: it has re-established itself in recent years, carefully protected by conservationists.

Mammal life Some distinctive mammals survive in the Scottish pinewoods. Although the ever-increasing American grey squirrel has, during this century, replaced the native red squirrel in so much of Britain, it has not yet secured a dominant position in the Highland pinewoods. There the red squirrel still thrives, perhaps better adapted to pinewood

Rise and fall of the pinewoods

Together with birch, the Scots pine was one of the first trees to spread to Britain from the Continent, towards the end of the last Ice Age about 8000 years ago. Then, as the climate continued to grow milder and wetter, southern Britain became ever more suitable for broadleaved forests of oak, alder and ash. These gradually took the place of pine except in the Scottish Highlands, where it survived in great forests until the late middle ages. From then on, particularly in districts where lakes and rivers were available for the transport of timber, the forests were steadily exploited. The heaviest losses were during the industrial revolution, when the iron-smelting furnaces used charcoal in vast amounts, and in the two world wars of this century. Today the old Caledonian forest is reduced to relatively small areas: some of these are in valley bottoms, some on islands in lochs, and some are on hillsides 600m (2000ft) and higher.

original extent

▲ areas remaining today

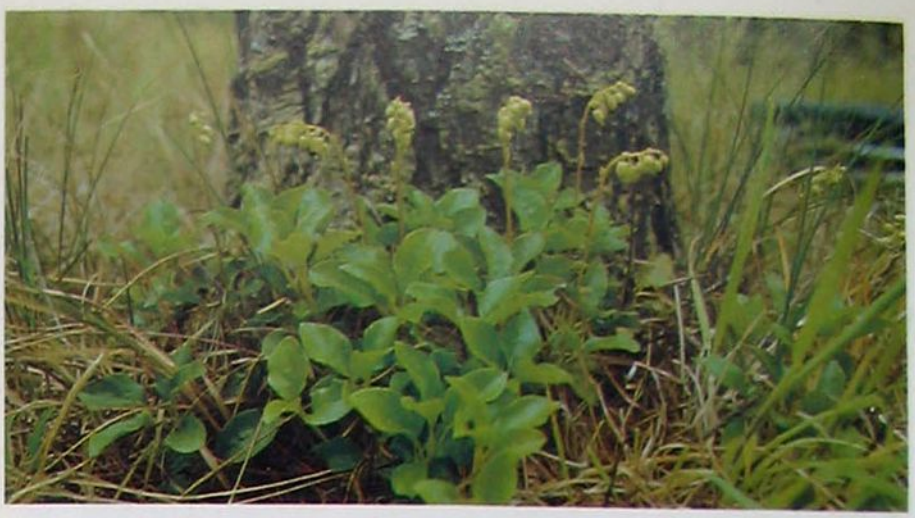
life than the grey squirrel, which does so well in broadleaved forest.

Strong and agile enough to prey on the red squirrel is that beautiful dark-brown member of the weasel family, the pine marten. However, the pine marten probably lives mainly on the voles and mice it catches on the woodland floor. Perhaps its chief rival predator is the wild cat which, like the marten, has had a history of persecution but is now recovering and spreading.

Roe deer and the much larger red deer are plentiful in and around the pinewoods. You may meet with roe in the woods at any season; and especially during the rut (July–August) you can hear their gruff bark. The red deer take to the high hills in summer and come down into the woods mainly in winter. Both deer are destructive of trees and in many places their numbers are kept down by shooting. But they are as beautiful and natural a part of the forest as the trees themselves, and it is just as desirable that they, too, should survive.

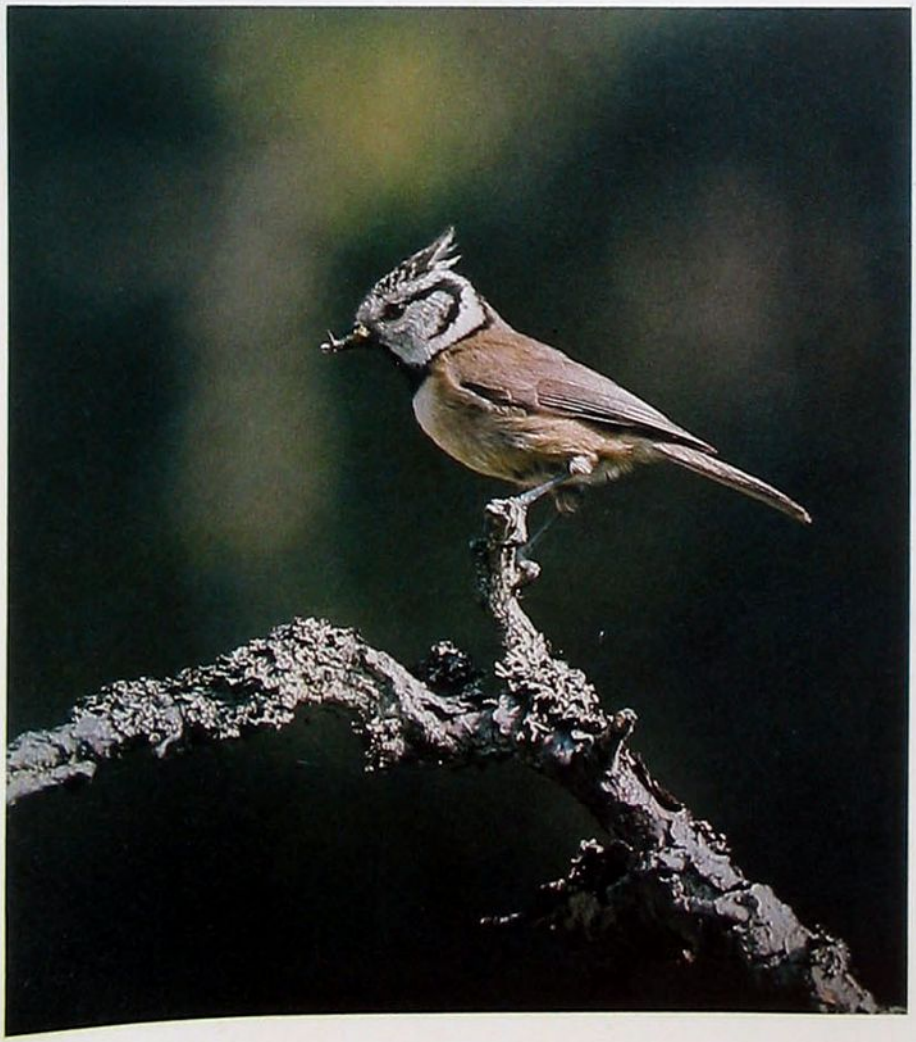
The conservationist's problem is how to make the delicate adjustments that will keep the balance between deer and trees. To achieve this, funds must be found for deer fences to protect young pines until they are mature enough to withstand deer damage.

Conservation Where are genuine relict areas of the Caledonian forests to be found today? They are widely scattered over the Highlands, some north-west, some south-east of the Great Glen which slices right across the country. Among the best known woods are those of the eastern Cairngorms in the upper valleys of the Spey (Abernethy and Rothiemurchus Forests) and of the Dee (notably at Ballochbuie). South-west of the Cairngorms on the southern shores of Loch Rannoch lies the Black Wood of Rannoch. Just north of the Great Glen are several fine forest areas including those of Glen Affric. And away in the north-west is Loch Maree, with its unspoilt pinecovered islands and the tree-clad slopes above.



Above: Serrated wintergreen is the smallest of the wintergreens, from 3–10cm (1–4in) tall. All the wintergreens live up to their name by keeping their leaves all the year round.

Below: The crested tit lives on insects high in the trees, only occasionally eating pine seeds.



What of the future of these ancient pinewoods? Is the story of their long decline to continue? Probably not, because their value for nature conservation and their contribution to the beauty of Scotland's landscape is now more generally recognised than before. Over 80% of the remaining area is regarded as being of national importance for nature conservation and about 30%, comprising the great woods at Beinn Eighe, Glen Strathfarrar, Glen Tanar and parts of the Rothiemurchus and Mar woods in the Cairngorms, are already in National Nature Reserves.

Now there are positive policies in force, which have changed the prospects for the Caledonian forest. The Forestry Commission actively encourages conservation and regeneration of the woods, and also manages several smaller remnants within its plantations. The Nature Conservancy has pursued a policy of negotiating management agreements with private owners whose land includes areas of valuable native pinewood. The government offers enhanced forestry grants to encourage owners to maintain native pinewood, for example by protecting young trees from nibbling deer, or by planting young trees grown from locally collected seed.

While many practical problems remain in implementing the conservation programme, including that of deciding how much management a woodland can undergo while still remaining 'natural', there is little doubt now that the majority of the Caledonian pinewoods will be conserved and perhaps, in the course of time, even extended.

CONE CRACKING CROSSBILLS

With its overlapping crossed beak and acrobatic skills, the crossbill is perfectly adapted to life among conifer trees, breaking open their cones and feeding off the seeds.

Most birds and other animals live off a variety of food sources. Even if they eat only insects, for example, their own particular habitat still offers numerous different species to feed off. This way, if one source of food fails they can turn to another source.

There are, however, a few exceptions to this rule. These are the specialist feeders that live off just one particular source of food. The specialist is extremely skilful at obtaining its food and also well adapted for the task, so it is not likely to be bothered by competition from other species. On the other hand, it is vulnerable to variations in its food supply.

One of our few bird specialist feeders is the crossbill, a member of the finch family that

Male crossbills are usually brick-red with brown wings and tail; but there are considerable variations, some males being more orange or bronze. Despite being so colourful, they are surprisingly well hidden among the foliage and cones.
Females are much duller, having the same brown wings and tail as the male, but with greenish-yellow parts in place of the red.

has adapted itself to feeding almost entirely off the seeds of certain cones. To this end, it has developed a special beak in which the upper and lower halves cross over and have sharp cutting edges. It inserts its beak into a cone, cuts through it with a scissor-like action and extracts the seed.

Separate species There are at least three distinct species of crossbill, each specialised at eating different types of cone. The common crossbill is the only one resident in the British Isles. It feeds off spruce cones. The other two are occasional visitors: the parrot crossbill, which has a heavier beak because its staple food source, pine cones, is more difficult to break open, and the two-barred crossbill with its lighter beak for dealing with the softer larch cones.

There is also a Scottish crossbill found in the Scottish pine forests that some naturalists think is a fourth, separate species. But this has not yet been confirmed.

Apart from differences in beak, all these species look alike. They are large and stocky for a finch, being about 17cm (6½in) long, but agile in their search for cones. They can even use their beak as an extra limb to help them climb through the branches.

They are not the easiest birds to observe because they tend to feed near the tops of trees, but the dropping of cones as they extract the seeds often betrays their presence, as do their calls. The usual note is a loud, repeated 'chup chup chup', but they may also make finch-like twitterings and calls.

Above: Male crossbill in search of a drink.

The crossbill's song usually advertises the acquisition of a mate or the establishment of territory in readiness for breeding. For much of the year crossbills stay in flocks, but as the breeding season approaches they split into pairs. Each pair selects a nesting territory which the male defends against intruders.

Crossbills often breed in mid-winter, since their food source is in good supply then.

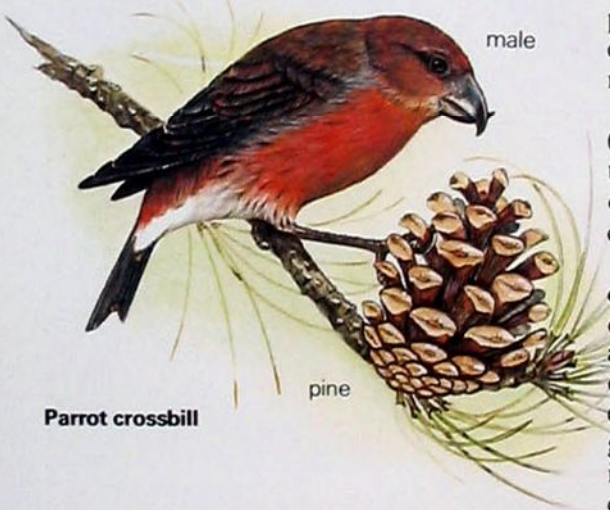
Feeding the female An unusual and important feature of the pair's pre-nesting behaviour is courtship feeding, where the male feeds the female. Besides helping to maintain the bond between the pair, the practice also provides the female with extra food to help with her egg production. It also tides her over the period when she is devoting much of her energy to building a nest, since the male rarely helps with this.

The nest is built anywhere between 2–25m (6–80ft) above the ground, often towards the tip of a branch. It consists of a foundation of twigs, lined with fur, grass, lichen and any other soft material to form a shallow cup.

An egg a day The eggs are laid at intervals of a day, a typical clutch consisting of three or four. Each egg is about 2cm (¾in) long and greenish-white with streaks or blotches of red, brown or black. The hen incubates the eggs on her own, though routines vary greatly. Some begin to sit when the first egg is laid, whereas others wait until the clutch is complete. In the former case, the chicks emerge a day apart and so differ enormously in size.

Incubation takes about two weeks. During this time the female is fed by the male, though if the cock is away for too long in search of food, the female may well leave the nest and

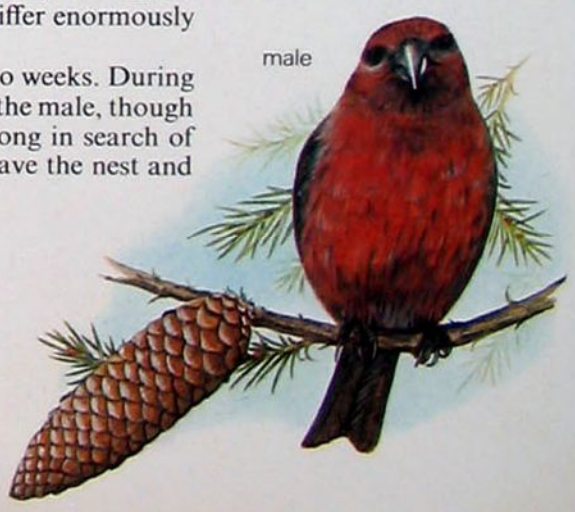
Below: **Common crossbill** (*Loxia curvirostra*). Resident, length 17cm (6½in). Feeds primarily on spruce seeds.
Parrot crossbill (*L. pytyopsittacus*). Occasional visitor; similar to the common crossbill but with a larger beak. Feeds on pine.
Two-barred crossbill (*L. leucoptera*). Occasional visitor; differs from the common crossbill in being smaller–length 15cm (5¾in)–with a smaller beak and two white bars on its wings. Feeds on larch.



Parrot crossbill

Common crossbill

Two-barred crossbill



feed herself near by.

This pattern continues for the first five days after hatching while the female broods her young. After this period the female leaves the nest for longer and longer intervals, during which she feeds herself and collects food for the chicks, often in company with the cock.

Slow growers An interesting feature of young crossbills is that they grow at a much slower rate than other young finches. They do not fledge until they are about 22 days old (compared with 15–17 days for other finches) and even then their beak has not yet crossed. This makes them completely reliant upon their parents for food for several more days. They do not become independent of them until they are at least 45 days old.

The reason for their slow growth is connected with their diet. Most finches (and young birds in general) receive a diet of insects, which is rich in easily digestible protein. Young crossbills, however, are given few insects. Their diet consists mainly of a paste of partly digested conifer seeds and mucus regurgitated by the adults. This is a much less nutritious diet than insects for young birds and restricts their growth.

Young crossbills are dull grey-green with pronounced brown streaking, especially on the breast and belly. As they mature they lose the streaks; females become slightly greener and males turn orange-red.

Massed invasions Because of their specialisation, crossbills are extremely vulnerable to fluctuations in cone production. If the crop in a particular area fails one year all the crossbills there are faced with a food shortage and have to emigrate to another area where the crop has not failed. So crossbills tend to be nomadic and their numbers in any one area vary considerably.

Occasionally this phenomenon takes place on a much larger scale. If the crossbill population builds up over a wide area through a succession of good crops, then the crop fails, vast numbers of crossbills emigrate. This is known as an irruption.

This happens periodically in Britain. The first recorded invasion here was in 1251; and it is due to an irruption in 1910 that England, particularly the New Forest and the Brecklands of East Anglia, supports breeding common crossbills.

Their ability to colonize our countryside will undoubtedly lead to greater numbers of crossbills in the future as large areas of post-war conifer plantations mature.

Above: A female crossbill feeding her young. Between two and six eggs may be laid, though a typical clutch consists of three or four.

Below: The common crossbill is found primarily in spruce forests, but it also inhabits much smaller groups of spruce, for example in East Anglia.

Left: A pair of newly fledged crossbills. Both male and female fledglings are dull grey-green with brown streaks on the breast and belly.
Compared to other finches, the young are unusually slow-growing and do not become independent for at least 45 days.

RETURN OF THE REINDEER

Usually thought of as a semi-domesticated nomadic animal of the Arctic Circle landscape, the reindeer was returned in 1952 to the glens and hillsides of the Cairngorms in the Scottish Highlands.

To see reindeer in the wild in the British Isles you have to go to the heart of the Cairngorms in Scotland and climb the hills of Glenmore outside the popular resort of Aviemore. The fact that this is the only wild herd of reindeer living in this country may seem strange. Discoveries of reindeer bones and antlers show that reindeer could be found over a wide ranging area in prehistoric times, although it is accepted that they had all died out by 7000 BC. In fact, the Scottish reindeer alive today are an example of a species that has been reintroduced successfully into the British Isles by the efforts and determination of the late Mikel Utsi and his wife Dr Ethel Lindgren.

Sweden to Scotland Reindeer breeder Utsi transplanted a few beasts from his own Swedish mountain reindeer herd to the Cairngorms in 1952. This cool mountainous region has conditions broadly similar to parts of northern Scandinavia. Later fresh stock from both Sweden and Norway reinforced the herd, and a Russian strain was added when a bull joined the herd from Whipsnade Zoo in Bedfordshire. Carefully managed, the reindeer flourished. By the late 1970s there were 80 beasts, and by 1980 about 600 calves had been born since the herd was first established.

Reindeer and red deer look similar from a distance, but there are several features that clearly distinguish the reindeer from red deer and indeed from all other types of deer. One important difference is that both sexes carry antlers (in other deer only the male grows antlers), although the bull's antlers are larger than the cow's. Another difference is that the first forward branch of one side of the antlers is often itself branched, and juts out above the face rather like a hand with outspread fingers. Reindeer are also able to survive nearer to the North Pole than any other deer.

Reindeer and caribou are thought by most authorities to be different races of the same species. Reindeer flourish in Europe and Asia where over one and a half million roam inhospitable areas of mountain and tundra. The caribou, which lives in a truly wild state unlike its semi-domesticated Eurasian counterpart, is found in North America.

In Scotland the reindeer roam thousands of acres of the mountain slopes of Glenmore Forest 400–900 metres (1400–3000ft) above sea level. Their range is not entirely unrestricted because the Reindeer Company that owns them sometimes corrals the beasts to check for ailments and to cull individuals for the venison meat market. Also each year the herd keeper (or volunteer guides) takes thousands of interested visitors on walks to see the reindeer. But apart from the time spent in enclosures when they are checked by the deer warder, they feed and breed much like their semi-domesticated counterparts in northern Europe and Asia.

Herd behaviour Like other reindeer, those found in Scotland form a herd containing animals of both sexes and all ages. Sex and age help to determine rank or 'pecking order'. During the autumn mating (or rut) the strongest bulls – often those with the largest antlers – tend to dominate all other bulls and the cows. However, mature cows outrank yearling bulls, which are smaller and weigh less than the cows. Calves come bottom of the pecking order unless a calf is close to its mother, when it shares its mother's status.

Cows become boss in winter. This is because the bulls shed their antlers soon after the autumn rut, but the cows retain theirs until the following spring. Thus cows move up the

Above: Reindeer cows in the Cairngorm snow, with Loch Morlich and Glenmore Forest visible behind. The herd of some 80 deer has been established since 1952 when the reindeer were first brought over from their Swedish mountain home by Mike Utsi. After quarantine on 300 acres near Aviemore, the reindeer were released in June of that year. More reindeer followed, some of the forest type and also a young Russian bull from Whipsnade Zoo.

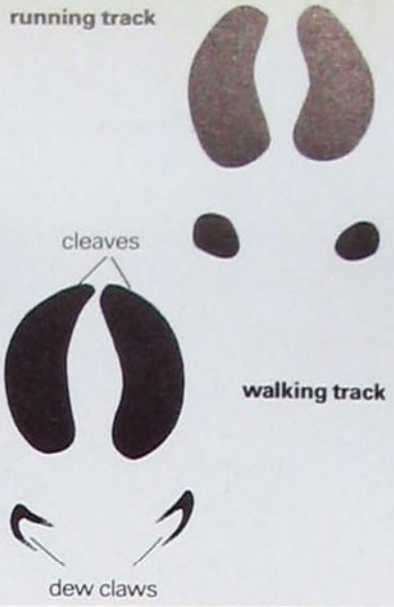
Below: Full speed ahead. A reindeer can run as fast as a horse over uneven or frozen ground. The antlers of this bull are developing and show their velvet covering.

Splayed hoofs for slippery slopes

Each half of a reindeer's splayed hoof roughly resembles a half moon. The whole hoof print is almost round with a clear-cut rim and two small marks to the rear are made by the large, low-positioned dew claws. Cows leave smaller, more pointed tracks than bulls.

The splayed, broad, flat and deeply cleft hoofs aid walking on soft ground and snow, as well as being well-designed to paw away deep snow to reach lichens underneath. Indeed this habit has earned the North American native reindeer their Red Indian name 'caribou' which means shoveller.

The hoofs also help to spread out the weight of the reindeer so that each hoof exerts a much smaller pressure than most hoofed mammals on the surface supporting the deer's weight. This helps to prevent the reindeer from sinking too much when travelling over deep snow or boggy ground. Hairs at the base of each leg grow quite long over and between the hoofs and help the deer to grip ice.



Right: Reindeer moss—the basic diet for reindeer in winter. It is not a moss, but a many branched lichen that grows to a height of about 15cm (6in).

Below: Creating a 'crater'—this is a hole pawed out by the deer in the snow to expose the lichen. It is thought the reindeer is able to smell the plant growing under the snow.

social rank, often driving the bulls away from the females in the herd.

The herd remains grazing in a relatively small area when not disturbed or lured away by the discovery of richer pastures. The reindeer keeper rounds up any strays that do occur, but a strong homing instinct means that these are just as likely to find their own way back in time.

The Scottish herd does not migrate up and down the mountains as do Scandinavian herds, because the winters are not as harsh as those of northern European mountains. However, when deep snow cloaks the lower slopes in winter, the deer tend to climb to drier ground.

Food for all seasons The reindeer is often thought to eat only reindeer moss. Although it does eat this plant, which is really a lichen, the deer has a varied diet including various other kinds of lichen—ground, rock and tree species. The reindeer in Scotland will search out lichens all the year round and in the Cairngorms the reindeer lichen is quite common.

In winter, when snow covers much of the ground, the reindeer knows exactly where to paw away the snow to expose the lichen carpet beneath. No one knows how the deer locates the plant but it may smell it.

In spring, signs of the winter foraging are visible as 'paths' grazed bare on lichen-covered ground. At this time, the reindeer also eats fresh green leaves of birch, willow, blaeberry and grasses that grow low down on the mountains. Some tender heather shoots are also cropped. In late summer and early autumn the deer search out fungi, even munching decaying specimens.

Like other deer, the reindeer also chew any shed antlers, as well as deer and bird bones they find—these are rich in phosphorus and calcium and help to maintain the mineral content of their bodies. The reindeer keeper puts out mineral licks and rock salt which also help to keep the animals healthy.

Autumn breeding Reindeer mate from late September to the end of October. With their antlers fully grown and hardened, bulls compete with one another for the cows during this period. When rutting, adults repeat a throaty roar and wield their hooves or antlers against any rival that comes too near. During the rut, each male mates with as many cows as his strength and opportunities permit.

The calves – usually one per cow – are born the following May or June. A newborn reindeer is on its feet within an hour, and soon makes its first attempts at running. The calves stay with their mothers in the herd, and within a month they are taking lichens and other plant food. But each calf is suckled with its mother's milk until the onset of winter.

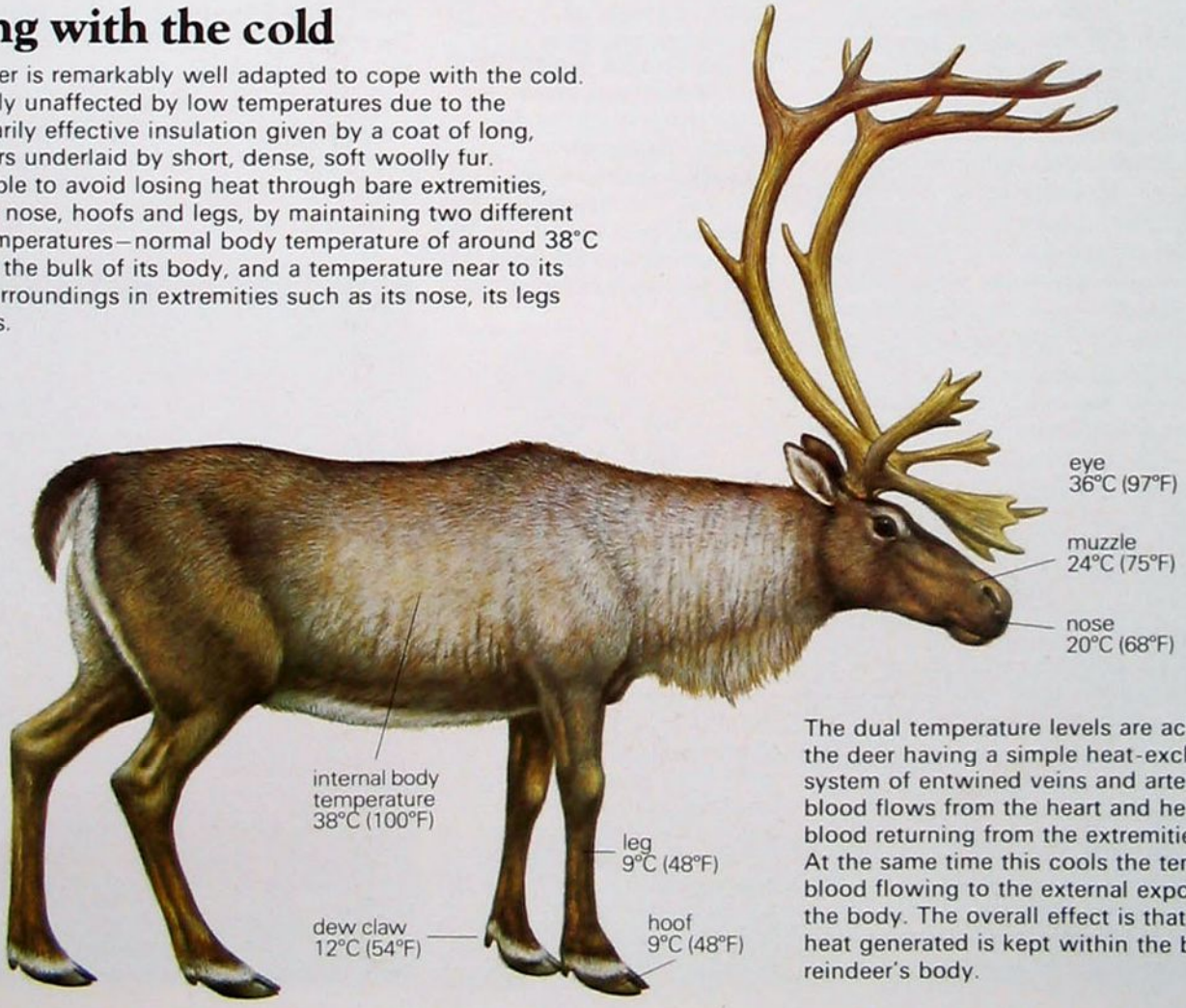
Antlers for digging The cow's antlers become extremely important in the winter, especially if she is with her calf. The cow exposes lichens in the snow which she and her offspring can eat. She also uses her antlers to defend her feeding patches, keeping other cows at bay as well as driving some bulls from exposed lichen feeding sites. (The bulls have by now shed their antlers, and are thus ill-equipped for fighting with protective females.)

Pests and enemies When reindeer were introduced to Scotland in 1952 they needed treatment for reindeer warble flies that had travelled with the deer in the form of eggs in the skin. The eggs hatch into maggots that eat the deer's flesh. Although this was cleared up by treatment with insecticides, native insects – including horseflies, black flies, mosquitoes and warble flies – are still troublesome at times. The reindeer normally escape these summer pests by climbing a mountain top, where the winds keep the insects at bay. However, in the few periods of warm weather, from June to the end of August, groups of animals are brought down to a corral for treatment. The insect repllent suited to the reindeer was selected in consultation with a chemical firm.

Above: A reindeer cow with her calf. The single calf is born in May or June and can keep up with a running herd within four hours. The calf's legs are quite long at birth compared to the rest of its body, the front ones being straight when it stands, and the back ones splayed out at the hocks to provide good support for the body.

Coping with the cold

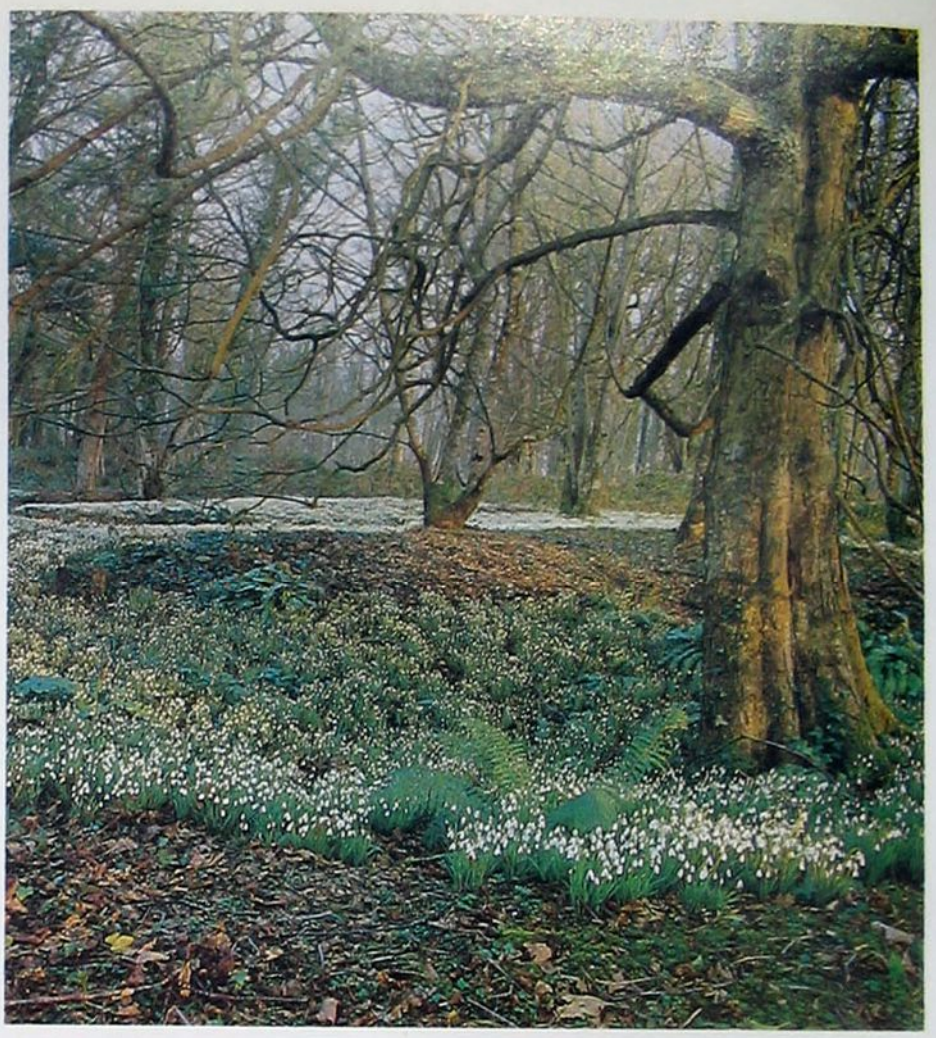
The reindeer is remarkably well adapted to cope with the cold. It is virtually unaffected by low temperatures due to the extraordinarily effective insulation given by a coat of long, hollow hairs underlaid by short, dense, soft woolly fur. It is also able to avoid losing heat through bare extremities, such as its nose, hoofs and legs, by maintaining two different internal temperatures – normal body temperature of around 38°C (100°F) in the bulk of its body, and a temperature near to its external surroundings in extremities such as its nose, its legs or its hoofs.



The dual temperature levels are achieved by the deer having a simple heat-exchange system of entwined veins and arteries. Warm blood flows from the heart and heats cold blood returning from the extremities. At the same time this cools the temperature of blood flowing to the external exposed parts of the body. The overall effect is that most of the heat generated is kept within the bulk of the reindeer's body.

RESTING IN WINTER

Looking at a stark winter scene, it is hard to imagine that within a few months it will be carpeted with spring flowers instead of snow. How do the flowering plants manage to reappear each year?



Above: Clusters of snowdrops appear in woodland from January until March, very often while snow is still on the ground—hence the alternative name of 'snow-piercers'. The flowers are protected by a leaf-like structure, which envelops them as they force their way upwards.

When a flowering plant overwinters, the foliage dies away to leave an underground food-storing structure, ready to produce new flowers and foliage in the spring. Although structures vary, they have similarities reflecting such common problems as cold and lack of sunlight faced by all overwintering plants.

Lifespan However, not all flowering plants are adapted to overwintering. Annuals are plants that live and die within a single year, relying totally on seeds to ensure their appearance the following year. Because only a fraction of the seeds produced is likely to germinate, annuals such as the rosebay willowherb produce vast quantities of seeds and tend to grow in bare or disturbed ground where the chances of survival are greatest.

Biennials last for two years, having the capacity to survive one winter. They do not flower in their first year, which is spent in storing up enough food to enable them to produce flowers and seeds in the second.

Perennials, on the other hand, are able to live for many years because of their adaptations for overwintering. They are often found in environments such as woodland, where thick ground cover and lack of wind makes it difficult for a seed-producing plant to establish a new generation.

If they are to live through the winter, plants must be able to cope with a number of problems, not least of which is the cold. To help them do this, the root, stem or leaves of the plant are modified to form distinctive underground overwintering structures.

Root structures The minimum modification to be found among perennials is the root-stock, which is the name given to a toughened stem base and root, capable of overwintering and storing food. It is a very basic structure, found in cultivated roses as well as wild primroses, but it is not always totally effective in combating the rigours of our winter climate.

Another simple overwintering structure is the root tuber, which is found in both biennials and perennials. Biennials, being most abundant in dry grassland, often have a long tap root for extracting scarce supplies of water, and into which food is passed during their first year of growth. The food causes the root to swell and form a root tuber as in the wild carrot or wild parsnip. (This is the part that has been developed by growers to provide us with the more familiar cultivated vegetable forms.)

Stem structures The most commonly found

Right: The early purple orchid possesses a mass of fibrous roots, which enlarge to store food and become root tubers. As with many of the flowering plants that overwinter rather than grow from seed, they appear early in the year, often in April, in woodland. Dog's mercury (in the background), which grows from a rhizome, may be seen as early as February.

modification for overwintering in perennials is the rhizome. This is really no more than a creeping stem that grows horizontally underground and can be used to store food material. It may appear in different forms: in Solomon's seal and dog's mercury the rhizome constitutes the main body of the plant, annually sending up an aerial flowering shoot. The rhizome of the Iris family, and of many grasses, is dominated by a terminal cluster of leaves and tends to lie closer to the soil surface.

The corm is a more complicated modification of the stem, which is shortened to an extreme to produce the stout, rounded body so familiar in the crocus. If the papery, brown scale leaves are peeled off the terminal bud, (which produces the main flowering shoot), and the axillary or lateral buds (which produce the foliage leaves) can be seen clearly within.

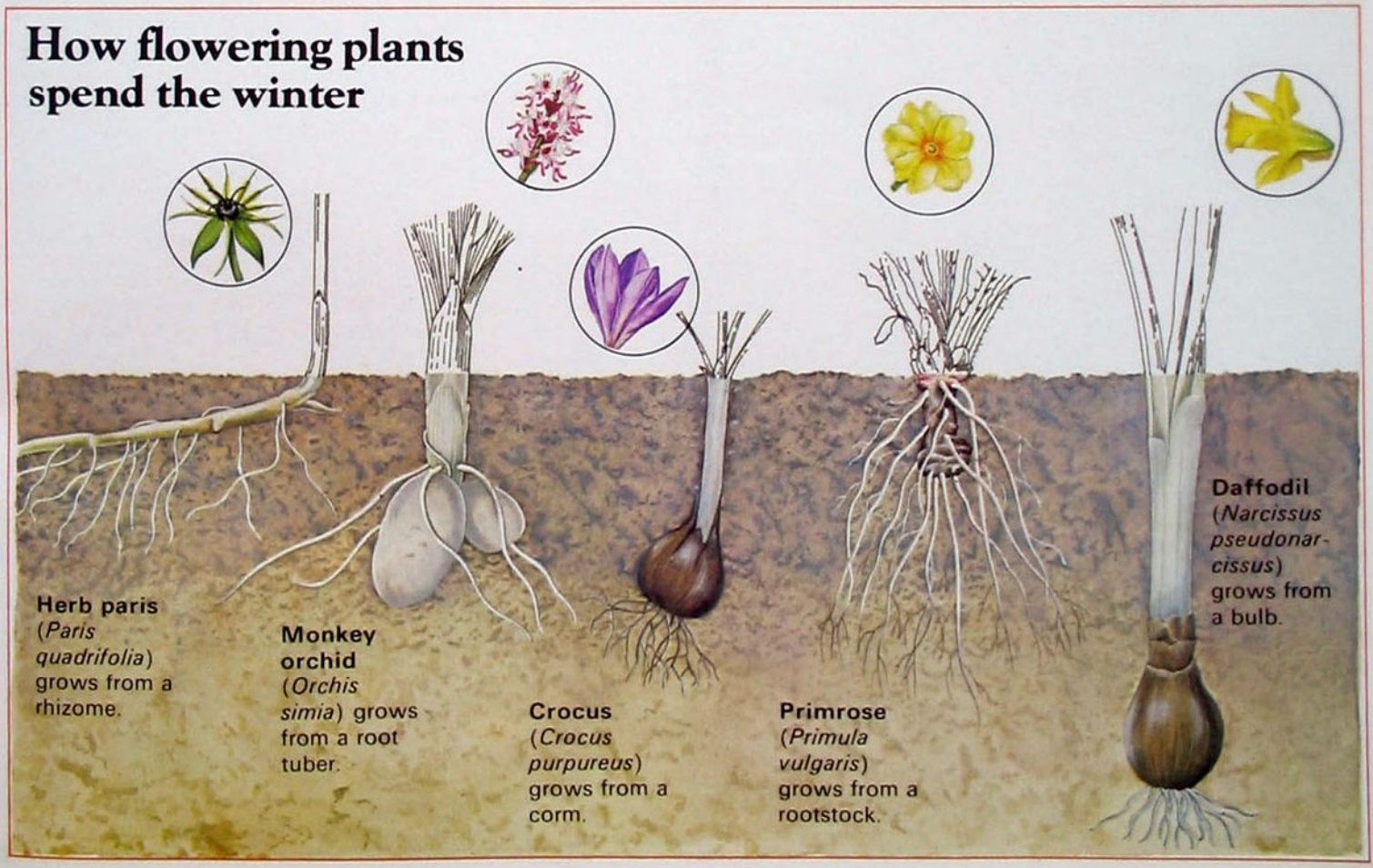
Food manufactured by the plant during the year is passed down to its base where it develops into a new corm directly upon the remains of the corm from the previous year. This would mean that over the years, corms would eventually form so close to the soil's surface that they would be in danger of freezing. This problem, which also affects bulbs, is largely overcome by the presence of special 'contractile' roots, whose function is to draw the structure back into the ground. In the case of the meadow saffron (a species of Lily and not a crocus), the new corm develops alongside, rather than on top of, the previous year's remains.

Rhizome—a creeping, swollen stem normally growing underground, sometimes seen on the surface.
Root tuber—swollen part of the root; stores food and lasts only one year.
Corm—fleshy underground stem; lasts only one year. New one grows from the old.
Rootstock—swollen stem base used to store food.
Bulb—constructed of fleshy leaves surrounding next year's flowerbud.

Above: The flower most associated with spring is probably the primrose. Small clumps of the yellow flowers are seen in woods and hedgerows throughout the British Isles from March onwards—even earlier after a mild winter. Once abundant, its existence is threatened in some areas, particularly near towns, as a result of over-enthusiastic collection.

Leaf modifications The most familiar overwintering structure of all is the bulb, which is typical of most members of the Lily family, including the tulip, daffodil and onion. Outwardly similar to a corm, it is formed from a greatly condensed shoot of stem and leaves. Unlike the corm, however, it is the leaves, rather than the stem tissue, that are modified for overwintering and food storage. This can be seen by cutting an onion in half, revealing the closely packed, overlapping leaves which have become thick and fleshy with stored food in the form of sugar. The tough, brown outer skin that protects the bulb is composed of the withered remains of the old leaf-bases. If it is left for any appreciable time in the light, a green flowering-shoot develops from the centre of the bulb, which provides all that is needed for the initial growth of the plant.

How flowering plants spend the winter


Herb paris (*Paris quadrifolia*) grows from a rhizome.
Monkey orchid (*Orchis simia*) grows from a root tuber.
Crocus (*Crocus purpureus*) grows from a corm.
Primrose (*Primula vulgaris*) grows from a rootstock.
Daffodil (*Narcissus pseudonarcissus*) grows from a bulb.

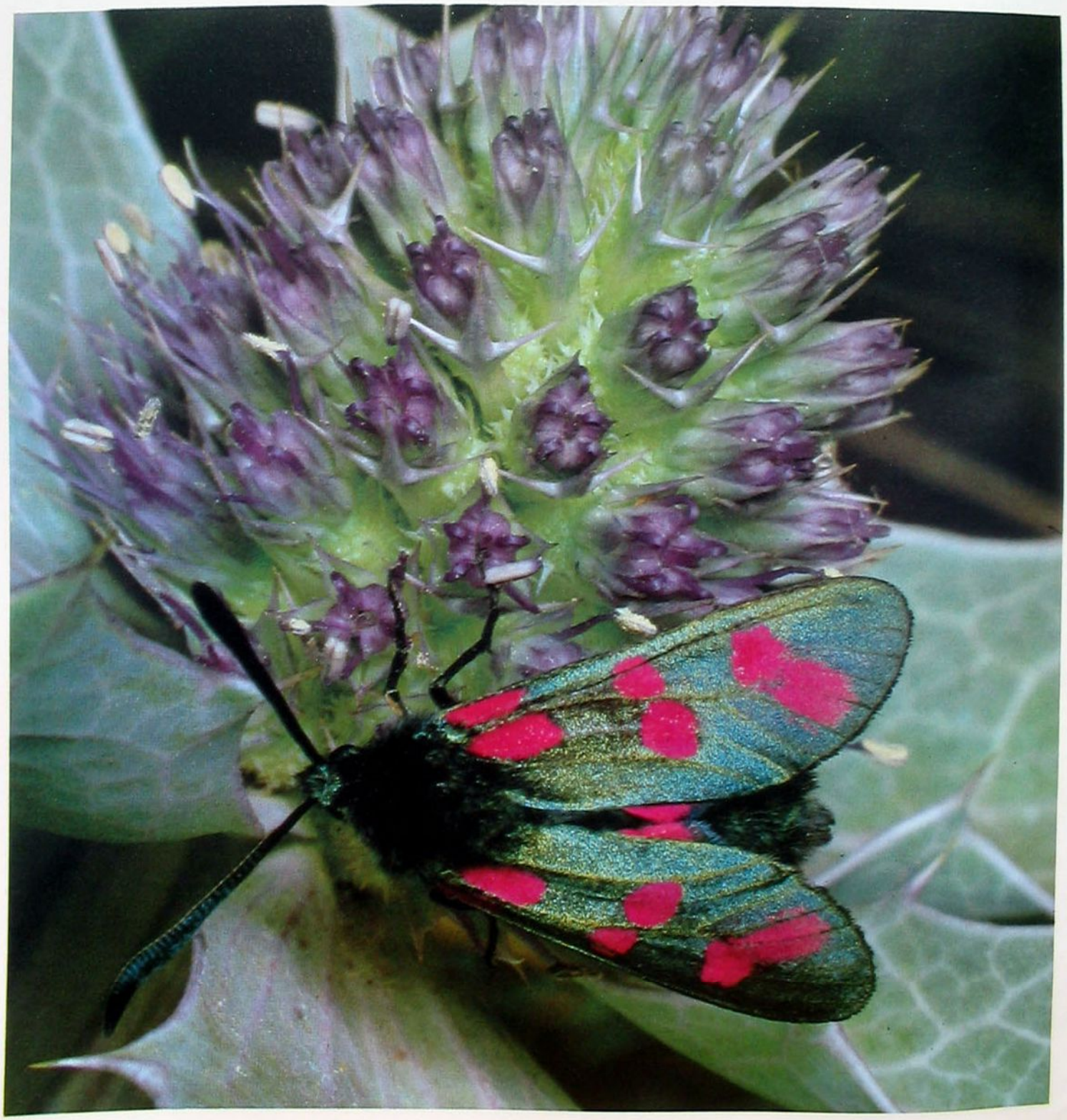
COLONIAL MOTHS

Burnet and forester moths, day-flying colony dwellers, overwinter as young caterpillars. They hatch in summer and feed until the approaching winter impels them to hibernate.

Burnets and foresters belong to a primitive family of day-flying moths, the Zygaenidae, and are notable for their sluggish and colonial habits. Being so sluggish, they are sedentary, rarely flying far from their haunts. The glossy, iridescent green or blue-black burnet moths, brightly spotted with crimson, are easily distinguished from the generally smaller, fragile-looking foresters which have uniform, brilliant metallic green forewings and smoky grey hind wings.

The burnets can be seen in their hundreds, swarming on the red or purple blossoms of knapweeds, scabiouses and thistles, usually in open, grassy countryside, but fairly often in woodland clearings and rides as well. You

The six-spot burnet moth (*Zygaena filipendulae*), with a wingspan of 3·5cm (1⅜in), is the commonest and most widespread of the seven burnet moths that occur in the British Isles. It can be found flying on sunny days from June to August. Like all burnets, it flies rather heavily but deceptively fast, appearing in a whirr of crimson as its hind wings come into play. It loves flower-filled, grassy places, where it lives in very large colonies.



may sometimes come across four or five crowded together on a single large flowerhead, all busily imbibing the nectar.

Brilliantly spotted burnets The six-spot burnet is the commonest of the seven species occurring in the British Isles. It lives in large colonies in flower-filled, grassy areas and can be identified by the six conspicuous crimson spots on each forewing.

The number of spots on its wings clearly distinguish the six-spot from the five-spot burnets, the two commonest of which are the very similar broad-bordered and the narrow-bordered. The narrow-bordered five-spot burnet can generally be distinguished from the broad-bordered by the two central spots on its forewings. If these are joined together, it is the broad-bordered; if they are clearly separated, it is the narrow-bordered. Unfortunately, the frequency of variation in these species, especially the broad-bordered, often complicates identification. Sometimes specimens can be found in which some, or all, of the spots are united, and others where the red colour is replaced by yellow or orange.

The broad-bordered five-spot burnet is not as widespread as the six-spot, but is locally common over much of England and Wales and also in the Isle of Man. Two distinct subspecies are found in Britain: *palustrella* flies in May and June on downland, whereas the larger *decreta* appears on the wing in late July and August and frequents marshland. *Decreta* caterpillars feed on greater bird's-foot trefoil, and construct cocoons high up on grass stems (presumably as a protection against flooding); those of *palustrella*, on the other hand, feed on common bird's-foot trefoil and pupate low down.

The narrow-bordered five-spot burnet, which usually spins its cocoon fairly high up on grass stems, is also locally common in England and Wales, as well as in the western parts of Scotland and the northern half of Ireland. The transparent burnet, which flies in June, is locally common in Ireland, Wales and Scotland; it has streaked rather than spotted wings. The other burnet species in the British Isles – the mountain, slender Scotch and New Forest – are all rather rare.

Above: Newly emerged six-spot burnet moths mating. When the moth is ready to emerge from its pupa, it forces its way up through the weak upper end of the cocoon and breaks out of the protruding pupa case, finally climbing higher up the stem to expand and dry its wings. Here you can see the black pupa case projecting from the papery white cocoon.

Left: A pair of short, plump six-spot burnet caterpillars.

Forest-green moths All three of our forester moths – the common, scarce and cistus – are on the wing in June and July, and some occasionally appear before the end of May. They can be found feeding in the sunshine on scabiouses and thistles, though the common forester seems to prefer ragged robin to all other plants. The scarce forester is particularly partial to the blossoms of salad burnet, one of the characteristic plants of its very localised haunts on the chalk downs of Kent, Sussex, Gloucestershire and Wiltshire.

The cistus forester is also very local, being confined to calcareous soils, mostly on hillsides in England and Wales as far

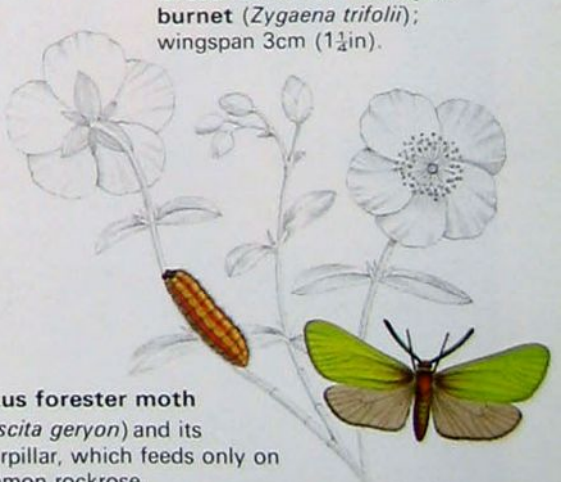
Narrow-bordered five-spot burnet (*Zygaena lonicerae*).

Broad-bordered five-spot burnet (*Zygaena trifolii*); wingspan 3cm (1¼in).

Poisonous protection

If a predator, such as a bird, attacks a burnet, the moth exudes both a strong-smelling colourless fluid and a greenish-yellow one from its thoracic glands; the latter fluid contains histamine and the extremely poisonous hydrocyanic acid. As soon as it tastes these highly unpalatable substances, the predator rejects the moth at once and does not readily forget the distinctive red and black pattern of the insect that contained them. In future the predator will avoid all burnet moths and probably other red and black insects too.

Curiously, although moth collectors had long known that burnet moths were remarkably resistant to the fumes of their cyanide killing bottles, it was only fairly recently that they found the moths' poison was hydrogen cyanide. All stages of the moth contain the poison, from the egg to the perfect insect. Fortunately, not enough poison is released to harm a bird seriously, much less a human being. Forester moths are also protected in this way.



Cistus forester moth (*Adscita geryon*) and its caterpillar, which feeds only on common rockrose.

Left: Common forester moth (*Adscita statices*); the female of this species is slightly smaller than the male, which has a wingspan of 2·8cm ($1\frac{1}{8}$in). It is not easy to separate the three British foresters. The common species is much larger than the cistus (*Adscita geryon*), which has a wingspan of 2·5cm (1in). The male scarce forester (*Adscita globulariae*) is as large as the common, but its antennae are pointed at the tip, not thickened. Female scarce foresters, with a wingspan of 2·2cm ($\frac{7}{8}$in), are considerably smaller than female common foresters, though slightly larger than the diminutive females of the cistus.

Below: Transparent burnet (*Zygaena purpuralis*). The caterpillars of this species, unlike those of most other burnets, feed chiefly on burnet saxifrage and wild thyme.

north as Durham, Lancashire and Yorkshire. In such places the moths fly on sunny, south-facing slopes where the smaller females seek out patches of common rockrose on which to deposit their eggs.

The common forester, although also local, is much more widely distributed in the British Isles. It can be found in many districts, especially in the south where it frequents meadows, downland, heaths and woodland clearings.

Overwintering caterpillars Burnets and foresters overwinter as caterpillars. They hatch from yellow eggs laid in the summer and feed until the approach of winter, then hibernate low down at the bases of their food plants and in nearby vegetation. The warm days of spring cause them to awaken and resume feeding on the fresh leaves of their food plants until they are fully grown and ready to pupate.

They are all fairly similar in appearance, being rather short and plump, and marked with rows of black spots and blotches. Those of the burnets, and the scarce forester, are green or greenish-yellow, while the caterpillars of the other two forester species are whitish. All species are fairly hairy, short hairs arising from the black or dark spots.

The caterpillars of five of our seven species of burnets normally feed on various leguminous plants, especially bird's-foot trefoil. The transparent burnet, however, feeds mainly on burnet saxifrage and wild thyme, and the mountain burnet almost exclusively on crowberry. The foresters, as a group, are rather more choosy. The caterpillars of the common forester feed on both common and sheep's sorrel, the cistus only on common rockrose and the scarce forester on greater and lesser knapweeds. When very young, the forester caterpillars feed between the upper and lower epidermal cell layers of the leaves. Later they consume only the lower cell layers, so that the attacked leaves take on a transparent appearance. When nearly full grown, the caterpillars dispense with the shelter provided by the upper layer and devour the whole leaf.

Spring-time pupation When fully fed and ready to pupate, usually in May in most species, the caterpillars spin somewhat boat-shaped cocoons. The foresters weave their strong, silken cocoons on their food plants and, when they are complete, change within them to shiny, olive-coloured pupae. The caterpillars of most burnet species attach their tough papery cocoons, which are whitish, shiny and sometimes tinged with yellow, to grass stems.

It is not difficult to find burnet cocoons. Since the moths live in colonies, often of a large size, the discovery of the first one or two should lead you to locate dozens more. Birds find it awkward to obtain a foothold on grass stems, so that most of the cocoons in such situations escape their depredations.

THE WORLD OF THE EARTHWORM

An inhabitant of an underground world, the earthworm is constantly at work unseen, enriching the soil as it makes its tunnels in grassland or beneath the lawn.

Digging the garden in the middle of winter may not produce many worms, because most of them move to deeper levels to escape the cold. However, it is rare to dig the ground at other times without finding some worms, for they exist in immense numbers in nearly every kind of soil. The highest populations exist under old pasture and other undisturbed grassland, where there is abundant food in the form of decaying roots and other plant material.

Estimates of the worm population of such places have been as high as three million to the acre, but half a million is probably a more reasonable average for grassland. Numbers are much lower in arable soils, for ploughing brings the worms to the surface where they are easily collected by birds. Up to 20 worms to the square metre is probably the norm for the average garden.

Such large populations obviously mean that earthworms have a major role to play in the ecology of the soil and their valuable ploughing activities have been appreciated for a long time. In 1777 Gilbert White, making a study of earthworm activity, wrote '. . .men would find that the earth without worms would soon become cold, hardbound, and void of fermentation; and consequently sterile. . .'.

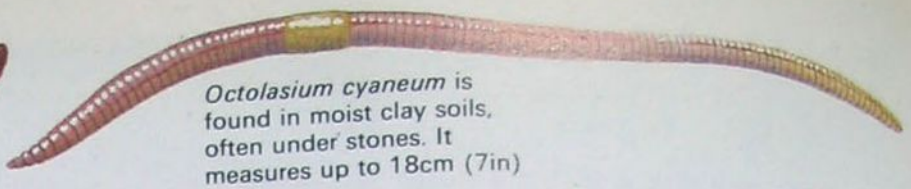
The earthworm family Earthworms are related to leeches and marine bristleworms; all belong to the large group of invertebrate animals known as the annelids, or segmented worms. Their bodies are divided up into numerous distinct rings or segments. Within the annelids, the earthworms belong to the class known as oligochaetes, a name meaning 'few bristles' which describes the animals very well.

There are about 25 species of earthworm

Above: *Lumbricus terrestris,* the most common garden earthworm, and the largest at up to 30cm (11¾in) long, lives in deep tunnels 1–1·4m (3–5ft) underground. Little piles of sticks and leaves sometimes mark the entrance to these tunnels.

Although earthworms are hermaphrodites, with both male and female organs in each individual, they still mate. In damp weather in late summer, particularly at night or in early morning, species such as *Lumbricus terrestris* (left) can be seen mating on the soil surface. They may stay in this position for several hours. Most other species mate in the rather safer confines of their tunnels.

Eisenia foetida, the brandling worm, is found on compost heaps. It measures up to 13cm (5in) long.



Octolasium cyaneum is found in moist clay soils, often under stones. It measures up to 18cm (7in) long.

Lumbricus rubellus is very common in gardens. Much redder than *L. terrestris*, it measures up to 15cm (6in) long.

Allolobophora longa is very common in gardens and produces casts on soil surface. It measures up to 12cm ($4\frac{3}{4}$in) long.

Earthworm reproduction When earthworms mate, they lie head to tail and envelop themselves in mucus which holds them together tightly. Then both release sperm, which the other collects in small sacs known as spermathecae. The worms then separate. When they are ready to lay their eggs, the clitellum secretes a mucous belt, which passes along the worm's body. It collects the eggs as it passes over the female opening and then sperm from the spermathecae, which fertilises the eggs. The mucous belt then seals around the fertilised eggs to form a protective cocoon.

Below: Worm cocoons may hold as many as 20 fertilised eggs, which hatch within a few weeks or sometimes months to produce small worms. The young worms are sexually mature after about a year and can live for as long as ten years.

in Britain, all belonging to the family Lumbricidae, but not all are strictly soil-dwellers. The brandling worm (*Eisenia foetida*), for example, prefers compost heaps and other decaying matter. Up to 13cm (5in) long, although usually very much smaller, this worm is easily recognised by its bold pattern of yellow and purplish-brown bands. It exudes a foul-smelling yellow fluid when handled.

The identification of soil-dwelling worms is not always easy, but mature specimens can sometimes be identified by the position of the saddle or clitellum – the prominent swelling in the front half of the body. Colour is also a useful guide, but the classification of earthworms depends largely on internal organisation.

Earthworms avoid really sandy and acidic soils, but can be found in all other types. They live mainly in the top 25cm (or 10in), although they retreat to lower levels in very cold or dry weather. *Lumbricus terrestris* has been found as deep as 2·5m (8ft). Most species remain active throughout the year, but *Allolobophora longa* and *A. nocturna* go into a resting stage in summer. They are often dug up in this condition – tightly coiled into a ball to resist desiccation. As worms do not have respiratory organs, they 'breathe' over the entire body surface, which must be kept moist at all times.

Built for burrowing All earthworms have slender and more or less cylindrical bodies, pointed at the front end and ideally suited for a life of tunnelling through the soil. There is no real head and there are no eyes or other special sense organs, although the whole body is sensitive to light and to vibrations. The mouth is right at the front, just under a fleshy lobe or flap called the prostomium. The rest of the body consists of a number of more or less identical segments, although the hind region may be somewhat flattened. In mature worms, a small region swells up to form the clitellum, which plays an important part in reproduction. The number of body segments varies from species to species, and also within a species according to its age and size. The number of segments cannot therefore be relied on for identifying species.

All but the first and last body segments bear four pairs of small bristles in the lower half. These bristles are much less numerous and obvious than those of marine bristleworms, but you can feel them readily enough by rubbing your fingers along the underside of the worm from back to front. The bristles play an essential role in movement and they also anchor the worm in its tunnel when necessary.

Nature's ploughmen Worms tunnel mainly in two ways – by excavating with their mouths and swallowing the soil as they go, and by forcing their way between the soil particles. The snout is pushed forward by hydraulic forces generated by the muscles acting on the body fluids. The movements are surprisingly powerful, as you will know if you have ever held a worm in a closed fist and felt its snout thrusting between your fingers.

The earthworm's food consists mainly of organic matter which is swallowed with the soil when tunnelling. Vast numbers of bacteria are digested as well as decaying plant roots. Undigested mineral matter is emitted from the hind end, but only *A. longa* and *A. nocturna* make the familiar worm casts on the surface. The other worms emit their excrement in the upper parts of their tunnels. By depositing these minerals at or near the surface, the worms counteract the

effects of rainwater, which soaks down into the soil along with the minerals it contains. The earthworms thus bring the minerals back into the main zone of the plant roots and therefore play a major role in promoting plant growth. The worms' tunnels also help to aerate the soil and maintain good drainage.

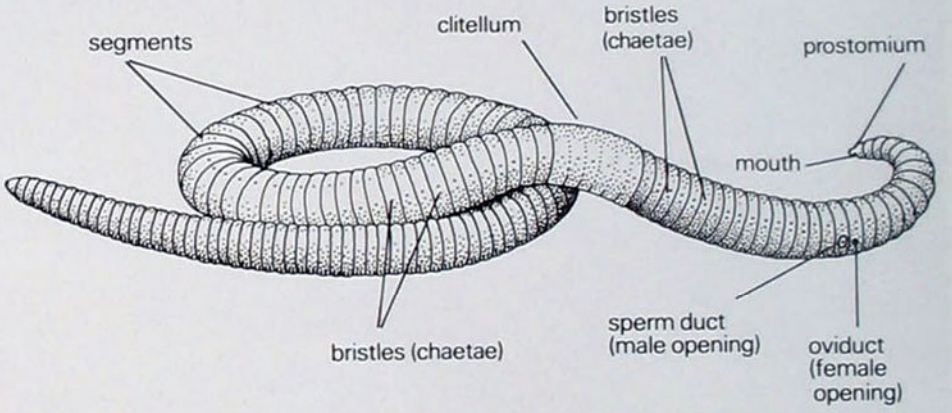
Because the worms can swallow only very small particles (under 2mm in diameter) and are continually bringing these to the surface layers, stones and other large objects are gradually buried on undisturbed land. This can be seen very easily by digging into a well-established lawn: very few stones will be found near the surface. Darwin made an intensive study of earthworms, writing a book called *The formation of vegetable mould through the action of worms*. His investigations showed that earthworms bury stones at the rate of about 5mm per year. The true rate is probably somewhat lower, but the undermining and burial of objects by earthworms is certainly a very real phenomenon.

Enemies above and below Earthworms do not spend all their time below ground: on a warm, damp night you can see them lying on the surface, especially on the grass. They are usually searching for dead leaves, which they then drag back into their burrows to nibble– the left-overs rot away, thus further enriching the soil. Their hind ends are always firmly anchored, however, and if you stamp your foot or shine a light on the worms, they generally retreat into their tunnels at high speed.

The worms usually retreat into their tunnels well before daybreak to avoid the traditional early bird; but even under the ground they are not safe. Birds can hear them tunnelling under the surface and plunge their beaks in to catch them. A frantic struggle then ensues, for the worms do not give up easily: their bristles anchor them so firmly that their bodies often snap before the birds can drag them out. If only a few segments are lost, either at the front end or the back, the worm can survive.

Underground, the worm's main enemy is the mole, which eats little else. In times of plenty, the moles catch and store large numbers of worms, biting the head ends off to prevent their escape. As the worms are not killed by this, they do not rot away. If the mole does not come back for them, they eventually regenerate the front end and crawl off.

Above: A robin takes food in the form of an earthworm back to its young. When the garden is being dug over, birds are often seen waiting nearby to swoop on any worms that may be turned up.



Going underground

The worm contracts the muscles at the front, pushing forwards.

As the middle part is drawn forwards, the front section thickens.

The worm draws up the rear end and starts to extend the front section.

The front is extended to start the sequence all over again.

Earthworm locomotion

Forward movement is produced by the sets of circular and longitudinal muscles, working in conjunction with the body fluids and the bristles.

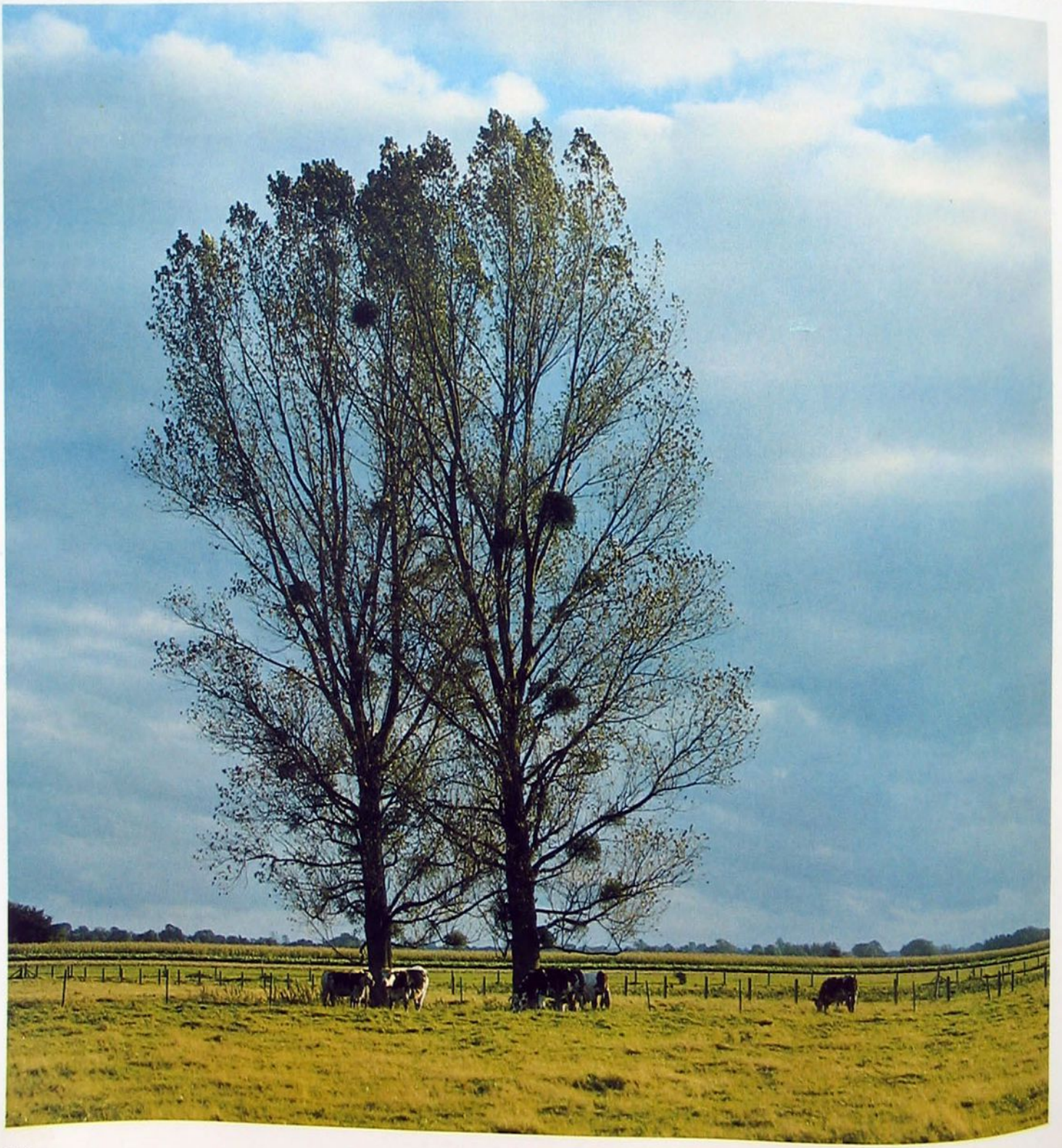
When the worm begins to move forward, it anchors itself with the bristles of the middle and hind regions; the circular muscles of the front end then contract, making this region thinner and at the same time pushing it forwards. The bristles then anchor the front end, while those of the middle region relax their hold. Contraction of the longitudinal muscles then draws the middle part forward and the front end becomes thicker again. The process is repeated to bring the rear end forward, and the front may also start to move forward once more. Movement is usually quite slow, but quick backward movement into the tunnel when disturbed is made possible by a set of large nerve fibres that cause the whole body to contract rapidly.

THE MAGIC OF THE MISTLETOE

Most people have seen mistletoe–if only hanging from a ceiling at Christmas time–but few are aware of its unusual life-style. For mistletoe is a parasite, living on trees and depending on them for its supply of water and nutrients.

Mistletoe is a small evergreen shrub found in southern England and the Midlands. It has been recorded on several host trees, including ash, maple, lime and hazel, but its most common host by far is apple with poplar in second place. Mistletoe can often be seen in parks and orchards; and in major fruit-growing areas it is locally common. However, it is no longer as frequent as it used to be in commercial orchards because the larger, longer-established apple trees that it prefers are now being replaced by modern bushy varieties.

Mistletoe anchors itself to a tree by putting out tentacles known as haustoria. These penetrate the tree's bark and grow into



the tissues to extract water and dissolved nutrients from the host's sap. But mistletoe does not rely entirely on the host for its food. It has green leaves and stems that can photosynthesize in the normal way to form energy-giving sugars. Because of this, mistletoe is not a complete parasite; it is more correctly called a semi-parasite.

Regular growth As a young plant mistletoe is extremely inconspicuous, especially since it is usually found high up among the branches of its host. But as the plant grows to form its characteristic spherical bundle of twigs and leaves, it can be seen clearly from the ground, particularly in winter when the host tree has lost its leaves.

Mistletoe has a regular pattern of growth. Each year each tip of its green stems divides to form two branches, each of which carries a pair of leaves. These are rather leathery, greenish-yellow and about 5-8cm (2-3in) long.

In April or May the flowers appear, though they are rarely seen, partly because the plants are so inaccessible but also because the flowers themselves are inconspicuous. They are extremely small and green, and so blend in well with the surrounding foliage. Male and female flowers are usually found on separate plants, either in the fork of the current year's branches or towards the end of these branches.

The flowers are followed by pearly white berries, about 1cm ($\frac{1}{2}$in) in diameter, each enclosing one or two small seeds embedded in a slimy flesh. The berries survive on the plant throughout the winter if they are allowed to, but they are more likely to be eaten by birds such as the aptly named mistle thrush. Consequently, many seeds are distributed via bird droppings, though most of these fall to the ground where they fail to germinate.

Fortunately for mistletoe, it does not rely solely on this haphazard method for its distribution. As the birds feed on the berries their beak becomes coated with the slimy pulp and the seeds. Occasionally, a bird cleans its beak by wiping it on some bark. The seeds stay on the bark and, as the slime dries and hardens, become glued to it, where they are able to germinate and form another parasitic clump.

Sacred to the Druids The strange parasitic nature of mistletoe has given rise to much folklore and tradition. The Druids of ancient Britain regarded it as sacred and magical. The most revered mistletoe grew on oak trees, but it could not be gathered by cutting it with anything made of iron because this was thought to destroy the mistletoe's powers. Instead, legend has it that the Druid high priests would gather the mistletoe with a sickle made of gold.

The Druids used the mistletoe as part of their rituals. After the rites it was customary to share out the plants for people to hang in their homes and ward off evil. It was also believed that mistletoe improved fertility provided it was not allowed to touch the ground.

These early customs probably account for our tradition of 'kissing under the mistletoe' at Christmas. Most of the commercial mistletoe seen in shops at this time of year is imported from northern France where it grows in abundance on poplar trees.

During the Middle Ages mistletoe was thought to cure a wide range of maladies. Epilepsy sufferers used to eat the berries or wear a sprig of the plant round their necks. Tinctures and extracts were prescribed for such diverse conditions as heart disease, gout, rheumatism and whooping cough.

Above: Mistletoe is most easily seen in winter when the host tree has lost its leaves.

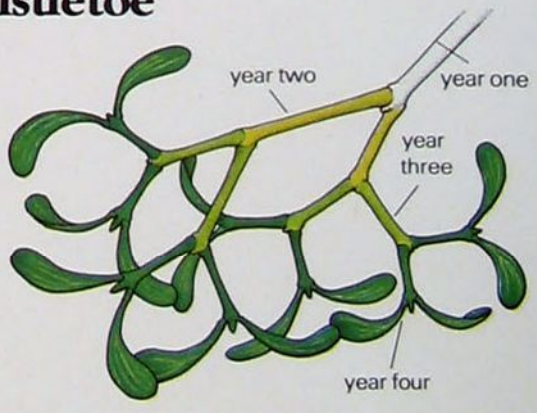
Left: Each berry contains one or two seeds embedded in a sticky flesh. The seeds are dispersed by birds.

Mistletoe (*Viscum album*), native evergreen shrub, parasitic upon trees, particularly apple. Inconspicuous green flowers appear April-May, followed by white berries Nov-Feb.

Male mistletoe flowers. Both male and female flowers are borne in clusters, usually on separate plants.

How to age mistletoe

Mistletoe grows in a strictly regular manner. Each year its growing points fork into two. This makes it easy to age a specimen. Trace back along a stem from the tip to the base and count the number of times it has divided. This number is equal to the age of the plant.



WINTER REEDBED

As winter approaches, the reedbed looks ragged, its tall stems battered and bent by the elements. Now all the marshland species prepare to face the coming cold and deprivation.

The common reed, the tallest British grass, is found in wet places throughout the British Isles. Reedbeds vary in size from narrow waterside fringes to large areas that extend over many acres. They are seen at the side of lakes where streams bring plentiful nutrients, or in the slow-moving water at the side of a lowland river.

The reedbed is a productive place: with the nutrient-rich water, plant growth is rapid and at the end of the summer there is a profusion of dying plant matter ready to fall to the ground. This produces a thick peaty layer beneath the standing stems of the reeds. The reeds need water in the soil to grow, and so often stand with their roots submerged in the marsh.

Winter hardship The marsh in winter is a less inviting place than in summer. In spite of the desolate appearance, however, life has not come to a complete standstill. Many creatures have made preparations to survive the adverse conditions, and the changes that take place in some life cycles alter the conditions for other species. For example the insects that flew during the summer are now overwintering–as larvae, eggs or pupae. These lie in the ground, the undergrowth or the water, where they are out of reach of the insect-eating birds. The sedge warbler cannot feed on these, and so it has already migrated to its marshland haunts in tropical Africa. For similar reasons the marsh warbler has returned to East Africa, and the reed warbler to India and the Persian Gulf.

One of the most spectacular insects of the reedbed in summer is the swallowtail butterfly, whose dwindling habitat includes parts of the Norfolk Broads. The adults have mated and laid eggs earlier in the year and the caterpillars, now fully grown, prepare to overwinter in the pupal state. Adult dragonflies, conspicuous in summer, are dead, but their eggs lie under the water and the nymphs will emerge from these.

Active mammals Coypu were introduced in this country from South America in the 1930s to be farmed for fur. Some escaped and many now live wild in the reedbeds. Coypus do not hibernate and are therefore out and about looking for a supply of food all through the winter. Feeding on coarse vegetation, these rodents are partial to the reeds. In large numbers they can cause extensive damage to the reedbed, trampling it into a quagmire.

If the frost is severe, coypus are likely to suffer from frostbite and die; even if they do survive, they become inactive and their breeding is brought to a halt.

The water vole is commonly found as a resident of the reedbed and surrounding areas. During this time of year, when food is less easy to come by, the water vole builds up its store. It is mainly vegetarian in its habits, although it will take some animals, including snails; piles of shells outside the entrance to its bankside burrow are a testimony to its activities.

Where there are extensive reedbeds the otter may lie under cover. It uses reed stems to build itself a comfortable platform on which to rest. At the end of the day, it sets

Above: Bundles of cut reeds lie awaiting collection –perhaps on a traditional boat known as a reed lighter. Most of our commercially cultivated reedbeds are in East Anglia and Scotland. Reeds are an excellent roofing material because they trap air, thus having ideal insulating properties.

Below: The water rail lives on insects and aquatic creatures such as freshwater shrimps. It also eats berries and seeds, as well as watercress and the roots of some grasses.

out on its long nocturnal journey up a nearby river, in search of fish.

Marsh harrier This agressive bird of prey can be seen quartering low over the ground in search of its food. As it passes only a few metres above the reeds, its keen eyesight will pick up even the slightest movement below. The presence of a water vole may be betrayed by a ripple in the water, or the black head of a coot may come into view. The marsh harrier's claws and beak, adapted for its life of hunting, ensure that the victim is taken with a minimum of fuss.

The bittern is typically associated with the reedbed. It disappeared from the British breeding bird list in the middle of the last century. It returned early in this century, but is now on the decline again. It is estimated that there are no more than 50 breeding pairs in the British Isles. The inconspicuous, brown mottled feathers of the bittern, excellent camouflage at any time of the year against a backdrop of reeds, enable it to remain virtually hidden in its marshland home. The only sign of its presence in the reedbed is its booming call, which can usually be heard from February onwards.

Water rail Reeds and sedges provide adequate cover for another secretive bird, the water rail. However, when frost or snow prevent it from finding its food under this cover, it has no alternative but to swim out onto the open water, where it catches small fish to supplement its normal diet.

Bearded tit Although each winter brings a period of some severity, it is the prolonged cold snaps which present difficulties for the smaller birds. Species such as the bearded tit are severely affected by these. Small in size, the bird loses body heat quickly and many die of cold. This is not the only problem the bird faces: another is finding food, often a hard task. As an insect-eater the bearded tit is more likely to suffer than the seed-eating birds. Living sparsely on what little it finds, the bearded tit may turn to the shelter of the reedbed. Male and female sit together on one reed stalk – he, with his wing over her body, keeps her protected.

Reed bunting Another bird encountered in the reedbed is the reed bunting. The winter population of this species is swollen by the arrival of visitors from the northern parts of the Continent. These resourceful birds have explored new habitats and are even seen side by side with chaffinches at the garden bird table. Such wanderings help them through the worst of the winter, until spring arrives – and with it a more plentiful supply of their varied plant and animal diet. This includes beetles, caterpillars and other insects, water snails, and the seeds of marshland plants.

Above: A coot picks its way to the edge of the reedbed, followed by a moorhen.

Right: The pupa of a swallowtail butterfly is attached to the plant stem by threads.

Below: The water vole is a rodent like the larger coypu; but it is not such a clumsy animal and causes less damage to the reedbed.

THE YEW: OUR OLDEST TREE?

With their hollow gnarled trunks and huge girths, some yew trees are believed to be more than a thousand years old. Not surprisingly, they are surrounded by legend and were once a symbol of everlasting life, despite being highly poisonous.

Below: Yew trees are usually encountered as solitary specimens, either in the open, as here, or in oak woods. Of the few yew woods that have survived, most are found on the chalk downs of southern England.

The common yew is often called the English yew, but in fact it is found wild from the west of Ireland eastwards to the Himalayas. From north to south it ranges from the lowlands of Scandinavia to Greece, Sicily, Spain and North Africa.

In Britain the yew occurs naturally in many areas, but usually only as isolated specimens. Woods wholly of yew are believed to have been plentiful at one time, particularly on the chalk hills of southern England and elsewhere on steep limestone ridges, both areas where the normally dominant oak would have failed to flourish.

Today, the best place to see wild yews is on the South Downs where Sussex meets Hampshire. Here you can still find yew woods, the most famous of which, Kingley Vale, four miles north-west of Chichester, is regarded as the finest yew wood in Europe. The area is now a National Nature Reserve and contains both young and old trees, some having been there at least five centuries.

Short and wide Yews occasionally grow to a height of 20m (70ft), but they usually reach only 12-15m (40-50ft). They are conical or rounded in outline and spread out to a great width, sometimes greater than the height of the tree. The shade beneath a large yew is extremely dense, so dense in fact that not enough sunlight passes through to allow any green plants to grow there.

The trunk is reddish-brown or grey and

Above: In February or March male yew flowers produce great quantities of yellow pollen. Usually it is blown away on the wind to fertilise nearby yew trees, but on a calm day it settles on the ground below, colouring it yellow.

Right: The fleshy red aril containing a seed. The aril is one of the few parts of the yew that is not poisonous. It is much sought after by birds, which eat it and excrete the poisonous seed intact.

Below: Yews are often found growing in the deep shade of a wood, though they may not flower in such dark surroundings. Yews themselves cast such a dense shade that no green plants can grow beneath.

often deeply fluted. In older trees its girth can be as large as 10m (35ft), though the trunk rarely grows to any great height.

The foliage is rich dark green, sometimes appearing black from a distance. Each leaf is about 10-20mm long, needle-like, pale green underneath and arranged spirally round the twig.

Wind pollinated flowers The flowers are borne on separate trees. Male flowers consist of small yellow spheres clustered together on the undersides of leaf sprays. In late February and March they release great quantities of pollen to be dispersed by the wind. The female flowers are smaller than the male flowers, and green, which means they are hardly noticeable until they develop into the fruits.

Fleshy cones When young the fruit resembles an olive-green acorn (the seed) set in a pale green cup (called the aril). In August the aril swells to envelop the seed almost completely and becomes fleshy and bright red, resembling a berry. Birds are much attracted to the fleshy arils, particularly mistle thrushes and blackbirds, and are the chief means of spreading yew seeds through the countryside.

Although the foliage of the yew resembles that of a typical conifer, its fruit is distinctly un-conelike and for many years botanists classified the yew separately from the conifers. But modern practice is to recognise the fruit of the yew as being a greatly modified cone, and the yew is now classed as a conifer.

How poisonous is yew? A notorious feature of yew is that nearly all its parts are poisonous: bark, leaves and seeds. The fleshy aril is, however, harmless and tastes sweet. Only this part of the fruit is digested by birds; the seeds pass through their bodies intact.

Its poisonous nature is due to the presence of several chemicals known as alkaloids peculiar to yew, one of which is called taxine. There are strangely differing reports about the effects of this poison on domestic animals. Some authorities are emphatic that yew foliage is highly toxic to all domestic animals, especially horses. Others state that it is only deadly poisonous when it is cut and dried. Still others report farm stock eating it without

Common yew (*Taxus baccata*). Native, evergreen tree, growing to a height of 21m (70ft). Some specimens have huge girths, up to 10m (35ft) round, though hollow, and are believed to be up to 1000 years old. Male and female flowers are borne on separate trees. Male flowers are rounded, turning yellow in Feb-March. Female flowers are smaller, greenish and inconspicuous. Fruit consists of a fleshy aril containing a single seed. The aril turns red in Aug.

Above: One of the few pests to attack yew is the yew gall-midge. It causes tufts of leaves to appear on shoots, but these galls seem to cause little or no damage to the tree.

Left: The yew, shown here with twig and fruit. The crown of the tree is often broad and conical.

Below: Many churchyards traditionally have a yew planted in them as a symbol of good fortune and everlasting life.

any ill effects, and one account even says that on parts of the Continent it is given to animals as a winter feed. Most likely, the truth is that yew is more poisonous in some districts than in others, that animals differ widely in their resistance to its poison and that the toxicity of yew varies with the season, according to whether the sap is running or not. Whatever the truth of the matter, it seems wise to treat yew with respect and to keep its foliage, whether green or dead, away from animals and the seeds away from children.

Durable wood The wood of yew is fine-grained, heavy and hard, yet springy. Even out of doors it is extremely durable: some of the oldest wooden weapons that archaeologists have discovered are made of yew. They date from the Palaeolithic times, about 10,000 years ago.

Because of the yew's strength and elastic nature the traditional use of its wood until the 17th century was for making long bows, though most English archers preferred the more expensive foreign-made bows, which were stronger and freer from knots. Other uses for yew wood have included furniture making, veneering and tool making. These days, however, there is so little yew wood available that its use is limited mostly to carving, turning and a little furniture production.

Difficult to date The age of the oldest yew trees is still a controversial subject. All these old trees are hollow inside where the heart wood has rotted away, so they cannot be dated by counting the annual rings. However, there are yew trees that are known to be about 300 years old, and they still look youthful, so it seems reasonable to guess at an age of about a thousand years for the oldest specimens. This estimate is supported by counting the rings in the outer wood; the oldest trees can have as many as a hundred rings squeezed into an inch of wood.

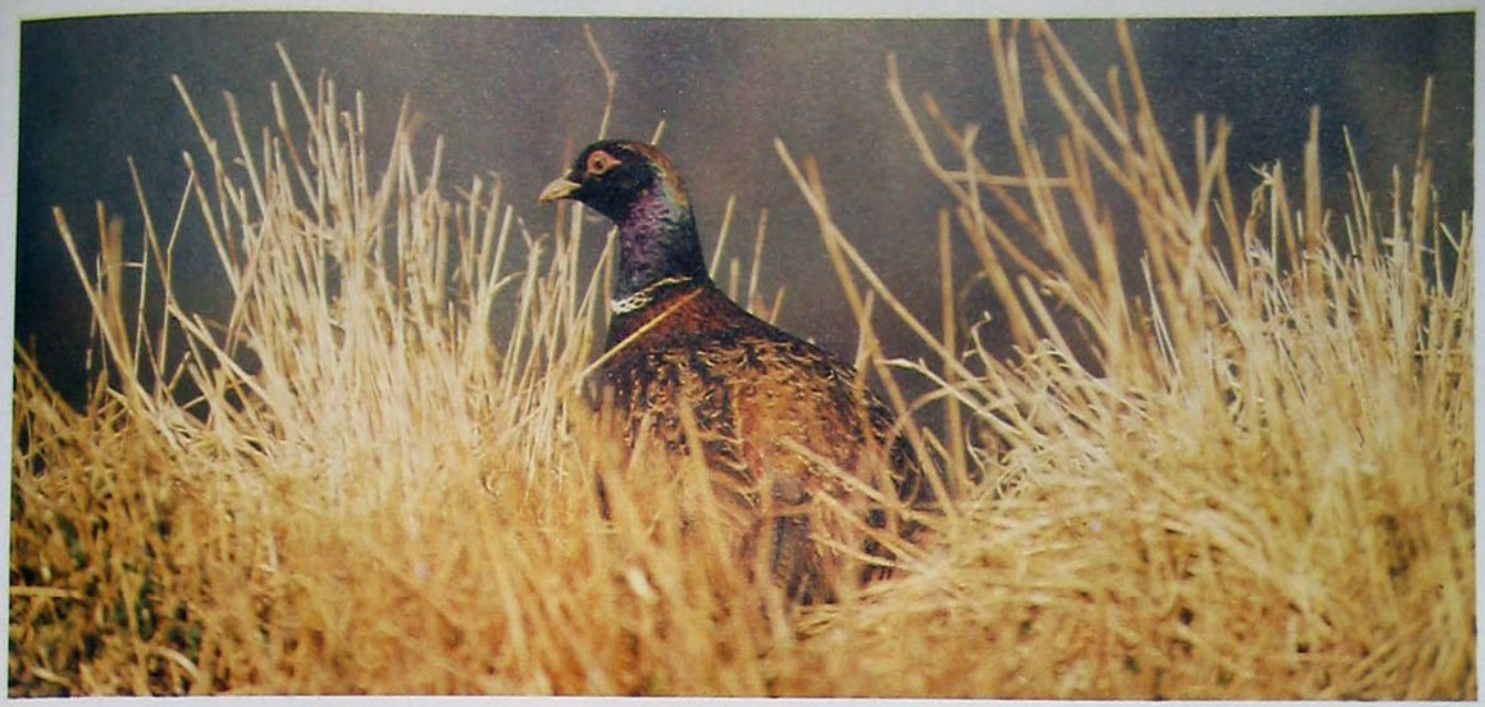
Many of our most ancient yews are to be found in churchyards, and if they are much more than a thousand years old they may well have marked the sites of pagan worship before Christianity. The shelter of a wide-spreading yew would have been an ideal place for the rituals of our Celtic predecessors.

With the arrival of Christianity these sites would have had churches built upon them. So began the traditional association between yews and churchyards, with the yew coming to represent the forces of good overcoming evil. The yew was also a symbol of everlasting life, and sprigs of it were buried with the dead.

Yet, against that, the yew has a long tradition as a gloomy, even dangerous tree. For example, in the 17th century it was thought unwise to sleep beneath a churchyard yew because the roots sucked up death and disease from the graves and exhaled them through its leaves. Probably man has always felt uneasy about a tree that is both sacred and poisonous.

PHEASANT: COLOURFUL GAME BIRD

Our largest and most familiar game bird, the pheasant, was introduced here about a thousand years ago. Since then it has become naturalised in most parts of the country.



Above: A male pheasant. Pheasants spend most of their time on the ground searching for food. They are usually found in habitats that provide them with some cover into which they can retreat when threatened.

Opposite: With its red featherless face and purple-green head, the male pheasant is one of our most brilliantly coloured birds. The female, however, is dull brown all over to give her camouflage.

Many people, including country-dwellers, are surprised to learn that the pheasant is really an intruder in our countryside, for the bird is not a native of the British Isles, nor even of Europe. It was introduced to these islands many years ago, but is now so numerous that it is accepted as a British bird.

The pheasant is a native of Asia. Its natural home extends from Turkey in the west to Korea and Taiwan in the east, and from Mongolia in the north down to Burma and southern China. Over this vast range a number of different varieties, known as subspecies, have evolved, each found in its own particular area and with its own distinctive variation in plumage. All of the early introductions were of a subspecies found round the Caspian Sea. The male of this subspecies is distinguished by not having a white collar. These birds did not come from their native area, however. More probably they were introduced to this country from stock living ferally on the Continent. When this happened is not known, but it was certainly before about AD 1060. These early birds were probably held in captivity as an extra source of food, but semi-wild populations soon became established.

In the 18th century another subspecies, in which the male did have a white collar, was introduced. This was the Chinese ring-necked pheasant. It hybridised with the natural collarless form, so that the modern male pheasant has a variable collar.

In the 19th century another pheasant species was introduced: the Japanese or green pheasant. Its hybridisation with the existing forms is believed to be responsible for some dark green variants that are occasionally seen today.

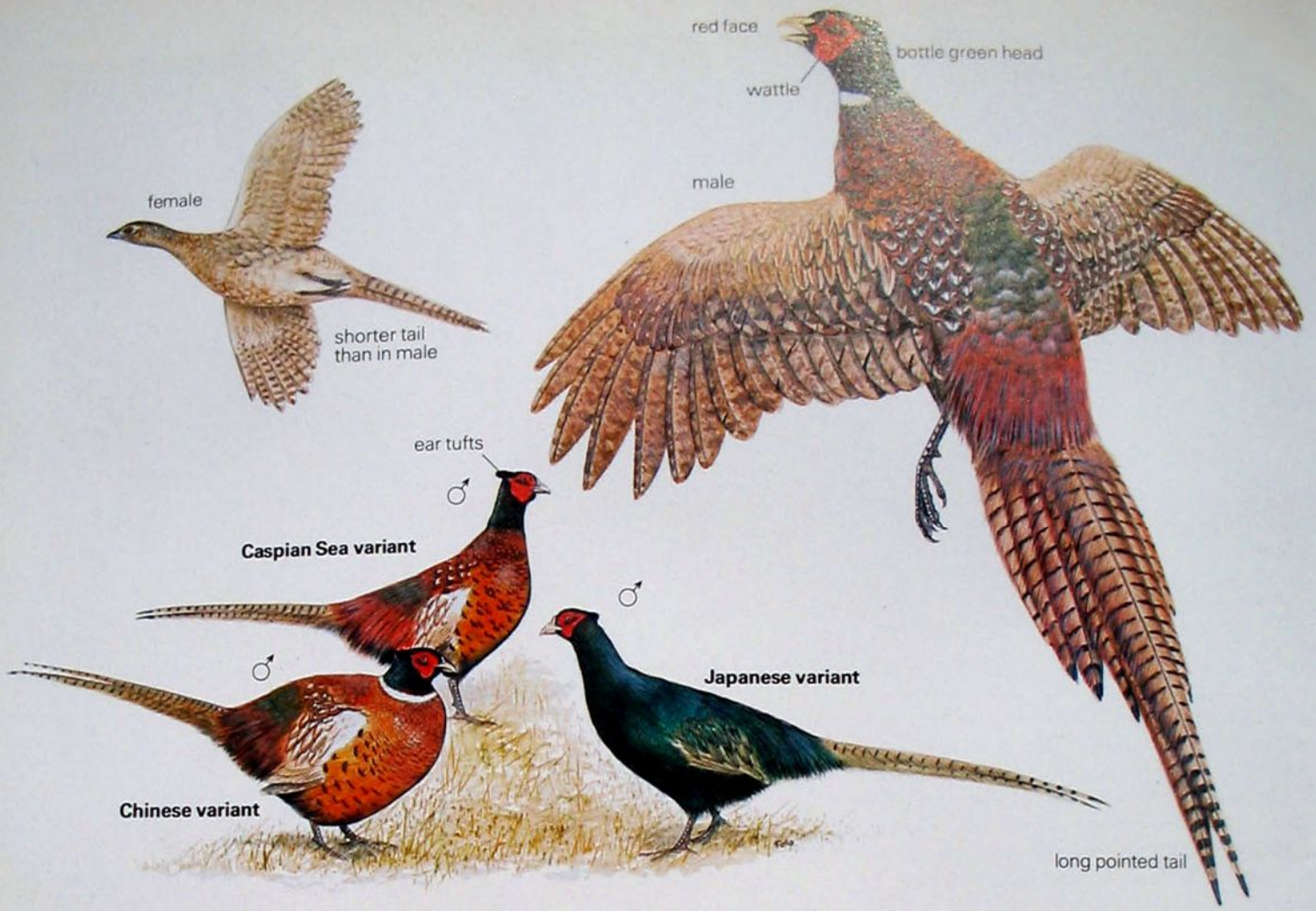
Unmistakable plumage Despite these variations in plumage the cock pheasant cannot possibly be confused with any other British bird. The head, neck and 'ear' tufts just behind the eye are a glossy bottle green with a purple sheen. Around the eye is a bare area of skin from which hangs a wattle. Both are vivid red. At the base of the neck is the collar, though it may not be present, or it may be incomplete and appear as a white crescent on either side of the neck.

The colour of the body is too variable to be described accurately, but it is mainly brown, or copper- or reddish-brown, with black, white and purple markings.

The female, by comparison, is a dull brown bird whose plumage is coloured primarily for camouflage, particularly important during incubation. Her general colouring is buff with darker brown or black barring, but at close range the buff feathers show pinkish tinges.

Ground dwellers Pheasants spend most of the daytime on the ground (though at night they roost in trees) and are potentially vulnerable to predators, especially the conspicuous males. Not surprisingly, therefore, they prefer habitats that provide them with some cover into which they can retreat when

Above: The body feathers of a male pheasant can vary considerably in colour and pattern. Usually they consist of a variety of browns, with black, white and shades of purple, though some individuals can be predominantly green. In this specimen the back feathers are black and white, tipped with brown. Next to them are the wing feathers.



necessary. Cultivated land with small thickets and copses, and even tall crops such as maize, provide good cover. In smaller numbers they also inhabit marsh and swamp land and, on high ground, wooded valleys.

When threatened, a pheasant usually runs for cover, but it can also take off, using its short powerful wings to lift itself vertically into the air with a noisy explosion of wing-beats. Once airborne, flight is fast but rarely lasts long and is never high. These short flights give pheasants only limited powers of dispersal: they rarely move more than 10km (6 miles) from the place of birth during their lives.

Although conspicuous enough in the open, pheasants are more easily identified in woodland by their alarm call: a repeated raucous 'kocock, kocock'. Cock pheasants also make a cockerel-like 'kokorok'. When used in territorial displays this is accompanied by a loud but brief bout of wing-flapping.

Territories and mates Most males begin their territorial behaviour from late winter onwards, when the winter flocks break up, though some males start as early as the autumn. Territories can be as large as 5 hectares (12 acres), but their size depends on the food supply, the number of other competitors and the kind of habitat – males need open areas large enough for their courtship displays.

During courtship the male parades around in front of his mate with short strutting steps. His head is held low, his feathers are puffed, wattles inflated and ear tufts erect. The wing closest to the female is drooped and the tail spread partly out and tilted towards her. Each male may have just one hen, but usually the male is polygamous.

The nest, made by the hen, is a simple depression in the ground, normally in dense vegetation such as tall grass or a hedge. Occasionally nesting may occur above ground – in a haystack, for example, or even up a tree in an old nest of another bird or squirrel. Surprisingly, the females sometimes nest outside their mate's territory, but they usually return to it to feed.

Eggs and young Egg-laying begins in late March, about 8-15 eggs being laid at daily intervals. The hen waits until all have been laid, then incubates them together. This way, they all hatch at the same time. Incubation, by the female alone, takes between 23 and 28 days.

The chicks are born downy. During their first few days they eat little, relying mainly on a yolk store that becomes absorbed into their bellies before they hatch. Once that is exhausted they feed themselves, though under close guard from the female. After only 12 days the chicks are able to make short flights, but they remain with the mother for up to 80 days.

At first, the young chicks feed mainly on

Pheasant (*Phasianus colchicus*). Introduced resident game bird, now widespread in cultivated land with small copses and thickets; also found in marshland and upland wooded valleys.
The male can be up to 90cm (35in) long, including tail. The female is shorter at 65cm (25in).

Gamekeeping

The job of a gamekeeper is to produce as many pheasants as he can for the shooting season. During the winter he traps free-living birds and puts them in pens to breed, each pen containing one male and between five and eight females. The eggs are collected and incubated, either by the females or in incubators. In the summer the young are released into the woods, but are still fed artificially.

Such dense concentrations of young pheasants are an attractive food source for predators and the gamekeeper tries to keep losses under control. Unfortunately, a few resort to illegal means, and even protected species of predators are sometimes killed. But this is only one side of the coin, for it is also the keeper's job to ensure that the correct habitat is available for the birds. Dense cover crops are sometimes planted, and many of our smaller woodlands are preserved by gamekeepers for their cover. Without the pheasant these woods would have disappeared long ago.

Above: A female pheasant sitting on her nest. This is often a simple unlined depression in the ground, normally in dense vegetation. Sometimes the female lines it with nearby plants and dead leaves.

Right: Egg-laying begins in late March. Between 8 and 15 olive-green eggs are laid at 24-hour intervals. Despite this, they all hatch together because incubation does not begin until the last egg is laid.

animal food, especially spiders. During the second week of life, the proportion of plant foods starts to increase, beginning with green material but eventually including seeds. By the time the bird reaches adulthood, its diet consists almost entirely of vegetable matter obtained from the ground by scratching the surface.

Game for the table Many farmers encourage the presence of pheasants on their land because they provide a valuable source of winter revenue through shooting. The game industry has become so lucrative recently that farmers are prepared to overlook the considerable damage that large numbers of pheasants cause, particularly in the spring when they feed off the newly sown cereal and pea crops.

Some farmers now employ gamekeepers to look after their stock of pheasants, rear young and provide vegetative cover. With such an ample supply of young pheasants available, many predators other than man take their share. Among gamekeepers, the kestrel, sparrow hawk and some of our owls have an unjustifiably bad reputation – unjustifiable because estimates suggest that only about a third of young pheasants raised are shot, which leaves plenty for natural predators. Furthermore, the mortality of young pheasants is the same in areas where they are shot as in other areas. The conclusion is that neither man nor natural predators are responsible for determining mortality. Food supplies are probably much more important.

Country attitudes are difficult to change, however, and the sight of a pheasant chick being carried off by a predator convinces many that, had the predator not struck, an extra bird would have been available for shooting in the winter.

Left: Pheasant chicks are born downy and are capable of feeding themselves from birth. For the first few days, however, they rely for food mainly on a store of yolk that they carry in their bellies.

EDIBLE OYSTERS OF THE SEA BED

Once a major part of the diet of the poor, oysters today are a much sought-after delicacy, cultivated and raised commercially in oyster beds. Tradition has it that they should only be eaten when there is an 'R' in the month.

Above: The European oyster is quite easy to cultivate, provided the sea bed conditions and water temperature at breeding time are right. Mature oysters are harvested with a dredge, a type of metal-framed net of wire mesh, which scrapes up the oysters from the sea bed as it is pulled along by a boat.

The oyster leads a sedentary life on the seabed, catching and eating microscopic algae and diatoms, suspended in the sea water, as they drift by. Like the mussels and scallops, it is a bivalved mollusc, the body protected by two thick shells or valves joined by a hinge and ligament.

Inside an oyster The animal inside the shells is rather flattened and has a feebly developed head at the front equipped with basic sense organs. Thin, flap-like folds run down either side of the body from the back to form the mantle flaps which secrete the shell. The flat, plate-like gills are contained within the mantle cavity; as well as being used for breathing, they play an important part in feeding. They are covered with thousands of fine thread-like cilia which beat the surrounding water, producing a current that brings oxygen to the oyster and carries away carbon dioxide. The current also draws in a supply of suspended food material, such as the microscopic plants on which the oyster feeds.

The heavy valves of the oyster shell are not identical in shape. The lower one is generally concave and 'cemented' to the sea bed; the smaller, flat upper valve closes down into it. The outside surface is rough and often discoloured or encrusted by a mat of organisms, including barnacles, algae and even other oysters. In contrast, the insides of the shells are polished and smooth.

Two major species of oyster are found in British waters: the native European oyster *Ostrea edulis*, whose shells are rounded in outline and reach up to 11cm (4¼in) in diameter, and the introduced Portuguese oyster, *Crassostrea angulata*. This is longer and thinner, reaching about 15cm (6in) wide and half as long. Both species occur in shallow coastal waters, especially in sheltered bays, estuaries and sea-lochs.

Danger in the sea Adult oysters are at risk from several predators. These include starfish, especially the common starfish *Asterias rubens*, and a whelk-like shellfish, the sting winkle *Ocenebra erinacea*. Starfish attack the oyster in an unusual way. They prise the valves of the shell apart by exerting constant

pressure with their thousands of sucker-feet. This creates a very narrow gap (sometimes only 1mm wide), through which they force the folds of their stomach.

These stomach folds, protruded out through the starfish's mouth are insinuated into the oyster and directly begin to digest the soft parts. When the meal is over, the starfish withdraws its stomach, leaving an empty oyster shell.

A similar sucking tactic is used by the sting winkle, a small sea snail with a powerful rasping tongue known as the radula. It uses this to cut a small hole in the oyster's shell, removing the animal's soft tissues with a long, sucking proboscis.

Dual reproduction The oyster is capable of changing sex several times a year throughout its life. Its reproductive organs are simple, composed of many branching tubes covering each side of the body. Sperm or eggs, depending on which sexual phase the oyster is in, are formed in these small tubes. Spawning takes place in the summer months when the sea temperature is high enough to stimulate the oysters to release sperm and eggs.

When the European oyster releases sperm, this is carried out into the sea along with the exhalant water current. The female phase oyster may produce up to one million eggs at one time, holding them in the mantle cavity where they are fertilised by sperm pumped in from the sea with the respiratory water. The development of the larvae of the European oyster takes place inside the 'mother's' shell, discolouring the gills.

This has caused oyster fishermen to refer to the brooding adults as 'whitesick', 'greysick' or 'blacksick', depending on the stage of larval development. Oysters are not considered good to eat at breeding time and it is a general rule that they are only edible when there is an 'R' in the month (that is, they do not breed from September to April).

The developing larvae of the European oyster are sustained within the gills of the mother by food contained in the yolks of the eggs. When they are mature enough to lead an independent life, they are flushed out into the sea by the rapid opening and closing of the shells.

The Portuguese oyster, which rarely breeds in our waters, reproduces slightly differently. Both sperm and eggs are released into the sea, where fertilisation and early larval development take place, divorced from the adult oysters.

Finding a home The emerged larvae of both species are known as spat and have the basic body structure of an adult. They remain feeding and swimming among the plankton for 7-18 days, depending on the water temperature, after which they start to look for a suitable hard surface on which to settle. They have a foot which they extend to test the sea bed; if the surroundings are not satisfactory, the animal will swim away in search of somewhere better. Once settled, the spat take only a few hours to achieve their final adult oyster form, after which they must remain in the same place.

When oysters are cultivated, the spat are collected and tranferred to suitable places for rearing to a juvenile stage. They are then returned to the original beds to mature.

Above: **Wing oyster** (*Pteria hirundo*). Lives on stones in mud, clay and gravel. Up to 7·5cm (3in) long.

Right: **Portuguese oyster** (*Crassostrea angulata*). Lives in shallow water, on rocks and in commercial beds.

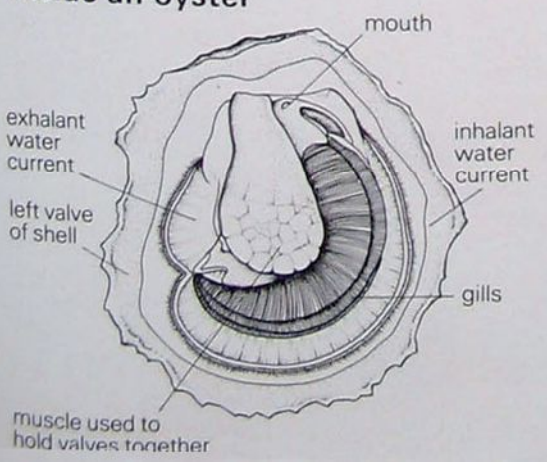
Below: **European oyster** (*Ostrea edulis*). Lives up to 80m (260ft) deep, on old shells or stones.

Left: **Common saddle oyster** (*Anomia ephippium*). Lives on rocks and other shells. Up to 6cm ($2\frac{1}{2}$in) long.

Above: A selection of oysters found in British waters. The saddle and wing oysters are not used for food, and none of the native oysters are pearl producers. The pearl oysters are tropical species, with important fisheries in Japan and the Middle East.

Below: The slipper limpet (*Crepidula fornicata*) is a pest on oyster beds. It lives in chains, often in large numbers, competing for the same food as the oyster, which may be smothered or crowded out of the oyster bed. Originally from North America, it was accidentally introduced into oyster beds in Essex around the end of the 19th century and spread rapidly.

Inside an oyster



GREGARIOUS GOATS
OF REMOTE HILLS
Country supersititions link goats with the devil because of their horns and cloven hoofs. No truly wild goats exist in Britain, but there are over 60 feral herds living in wild, remote places, which were established from domestic goat herds.

Owing to mixed origins from domestic breeds of goat, there is no fixed type of feral goat in Britain. In colour it can vary from pure white to jet black – although it is usually a mixture of brown, grey, black and white. The nanny (female) is more variable in colour than the billy (male) which tends to be grey or brown. The true feral goat normally develops a long, shaggy coat and fine, sweeping horns – present in both sexes.

Herding together Goats are strongly social animals, living together in family groups made up of several generations. Outside the breeding season males and females generally form quite distinct and separate herds, although males may be found at any time with female parties. In some cases the single-sexed herds occupy different geographical ranges.

'Female' herds, which in practice contain both females and their current offspring, are tightly knit units with a formal social structure. They are usually family groups, the females being related, as each female born tends to stay in her mother's group when she matures. The oldest female – the queen – leads the herd and each member knows its place and follows its leader in the clearly defined herd structure.

Billy herds are less rigidly organised than female herds, although a leader is usually present and a marked heirarchy is apparent. A number of old billies live solitary lives.

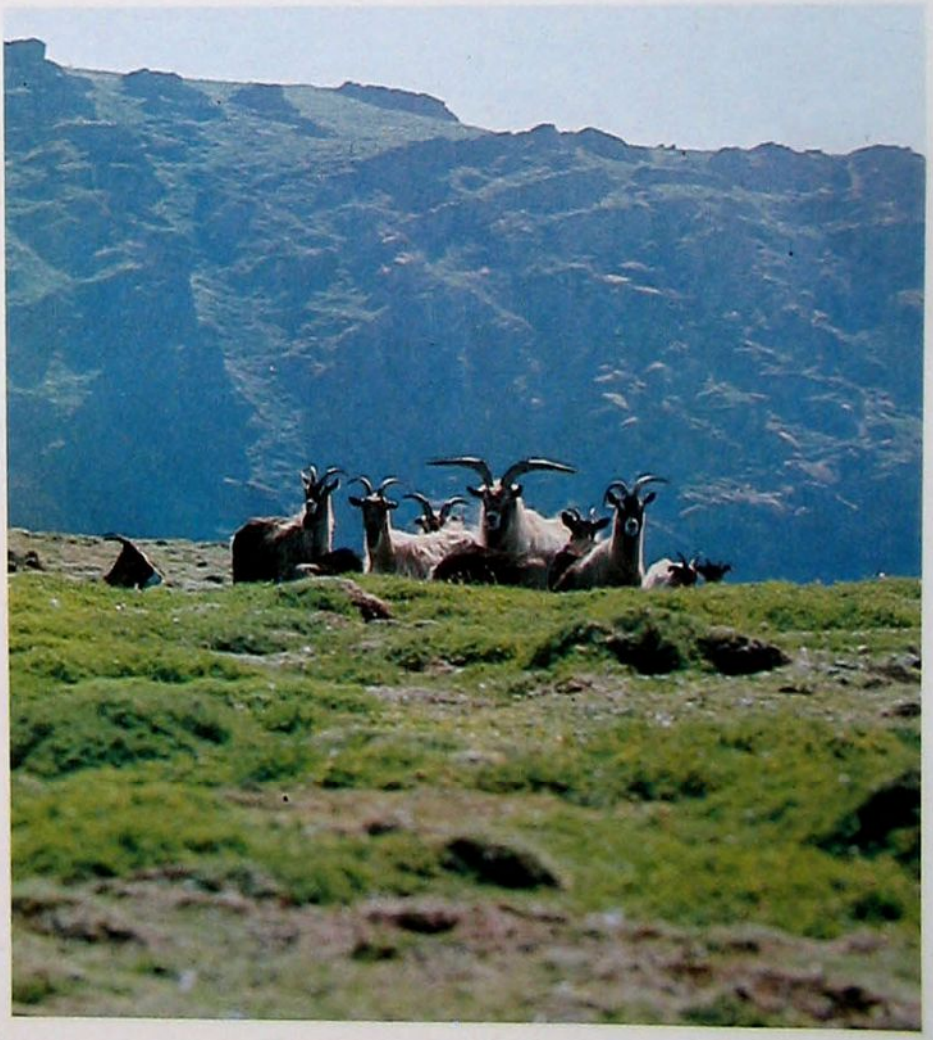
Horn-clashing fights Goats show a whole range of social behaviour. Aggressive displays are the most spectacular and resounding, as the contestants rear up on their hind legs and clash their horns together again and again. Although impressive, these combats are ritualised and the animals obey sets of rules imprinted in their behaviour. The animals meet only in head-to-head clashes or pushing matches, never attempting to jab a horn into the flank or underbelly. To take the shock of the clashing horns, goats have developed a specially reinforced forehead of thickened and spongy bone that strengthens the skull and absorbs the impact.

Horn-clashing displays are used not only in aggressive contests but also to strengthen the bonds within a herd and reinforce the position a goat holds in it. In such a contest, the 'fights' are still further ritualised, and the goats stop for short spells to lick each other's faces – a behavioural trait transferred from the more usual context of a mother licking her kids. Females do not fight, but nannies frequently whicker (a whinny-like noise) to each other when they meet and they may groom each other's neck and head.

Food at the top Like their truly wild counterparts, feral goats live mostly in rather rocky or mountainous areas on exposed cliffsides or hilltops. The nanny herds, with kids to support, tend to take over the more productive areas, while billies withdraw to the poorer parts of the range. This usually results in the nanny herds feeding on the lower, more nutritious slopes of mountain areas with billies being found higher up on the poorer rocky tops.

The forage includes coarse grasses, herbs and dwarf shrubs such as heather or bilberry. Unlike sheep, goats feed extensively on shrubby materials when these are available, plucking leaves and shoots from trees such as birch and rowan. They also bite off quite thick, twiggy stems and chew them up with apparent relish. Many goats strip bark from trunks and stems with sharp jerks of the lower incisors. Bark is a highly nutritious foodstuff and may compensate in part for the poor quality of the rest of the diet.

Above: Family foraging. Although both sexes grow horns, those of a male (right) – the billy – can reach up to a metre in length.



Below: Feral goats on the Island of Skokholm, off the coast of Pembrokeshire, Wales. The goats share the island with colonies of breeding seabirds such as shearwaters, storm petrels and puffins.

Left: A 'queen' leads her nanny herd to new feeding grounds.

FERAL GOAT (*Capra hircus*)
Size Male 30–45kg (66–99lb) female 25–35kg (55–77lb).
Coat Shaggy; colour very variable—ranges from pure white or grey-brown to a mottled brown, grey, black and white.
Horns Grown by both sexes, large and backward-sweeping.
Length Up to 75cm (30in), sometimes more.
Breeding season Rut begins mid-Aug or mid-Oct depending on latitude.
Gestation 150 days. Usually 2 kids born.
Food Hill vegetation, browsing rather than grazing.
Predators None, other than man; shooting parties for horns organised by trophy hunters.

Amazingly agile, goats frequently stand up on their hind legs to reach further up into tall trees.

Regular daily routines are followed by flocks of goats. The herd leader—billy or queen—knows all of its range in detail. According to the season and weather, it follows a strict and rigid route. Leaving a safe resting place among the rocks where the herd has spent the night, the billy or queen leads its herd each morning to favoured feeding places. When the herd leader stops to feed, the flock feeds with it; and when the leader moves on, the whole flock moves too.

The herd makes about 12 stops in different feeding areas during the morning, before settling down for the day on a suitable area of mixed forage. Here each animal feeds at its own pace and convenience, stopping for periods to chew the cud. The herd goes back to the safety of the rocks for the night.

Ardent smelly billies Males and females separated for most of the year, meet in early autumn to mate. The 'rut' is the time when males fight over individual females that are 'in season' (ready to mate). The rutting season begins in mid-August in the north of Scotland, but is delayed until mid-October in England and Wales. The billies—always somewhat smelly—develop an even more pungent odour at this time as special musk glands around the anus, at the base of the horns and below the eyes become highly active. The billy goats add little to the attractiveness of this effect by the curious habit of anointing themselves with urine.

Nanny goats become sexually mature from six months of age, but normally do not mate until they are about 18 months old. They come into season at 21-day intervals from the start of the rut and continue to come into season until January or February or when they conceive, (which ever occurs first).

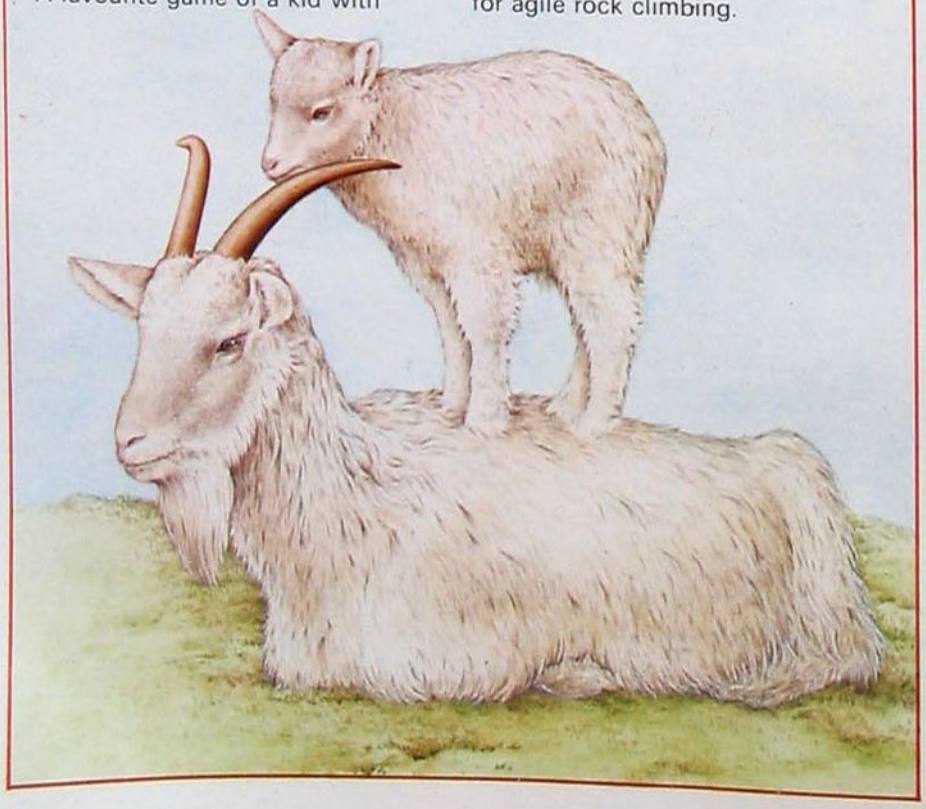
Billies identify females in season by testing their urine. Each time a female urinates, the billy rushes to the spot and sniffs the ground, or goes to the female and sniffs her bottom. Some females respond by urinating all over the billy's nose. The billy stands rigid, with his neck outstretched, and his top lip curls right back in a pronounced 'leer'. This behaviour is called flehmen and a specialised sense organ is exposed at the base of the upper lip that is sensitive to the chemicals contained in the urine. Dominant females also display flehmen and sniff at the urine of other goats.

When a billie detects a nannie in season, he courts her carefully, runs round her sniffing and snorting, licks her head and flanks and strikes out at her from behind with a rigid forefoot. If the nannie accepts him, she allows him to mount and copulate. If she does not want him, she turns and butts him away. A determined nanny is more than a match for an ardent billy.

King of the castle

A baby goat—kid—is born from January to April, twins being more common than a single kid or triplets. The kid stands within a few minutes of birth and grows rapidly.

A favourite game of a kid with its mother is 'king of the castle', when the kid jumps on the mother's back, surveys the surrounds and hops off, only to repeat the action time and time again. No doubt this is practice for agile rock climbing.



STRIKING PLANTS OF THE SEA

Familiar from holiday beaches, red seaweeds are in evidence in rock pools, on the shore, and in the sea throughout the year. But their beautiful underwater colour, varying from deep purple to pale pink, fades rapidly on exposure to sunlight.

Seaweeds have traditionally been classified into three major groups–red, green and brown. Most of the familiar, large seashore seaweeds are brown algae. But if you look closely into rock crevices, pools or under the cover of brown seaweeds, many different examples of red algae are to be found.

Their red colour is due to the presence of the pigments phycoerythrin and phycocyanin in their cells. These reddish pigments are able to absorb low intensity blue-green light, which is exactly the kind of dim light that penetrates deep water, crevices and among the brown algae, where the red algae live. Without the special pigments, the algae would not be able to live in such shaded places, or

Above: *Lithophyllum incrustans* is a calcareous alga, which generally encrusts rocks, or grows in layers.

Previous page: *Corallina officinalis* is found fringing mid-shore rock pools. The colour of its calcium-carbonate covered stems and branches varies from purple to white, depending on the light.

Opposite, top: Rock pools often reveal the pink algae *Corallina* and the large red-brown fronds of the edible carragheen (*Chondrus crispus*). These may turn green in sunlight, matching the green seaweed, *Ulva lactuca*.

in the deeper waters of the sublittoral zone (the area of the shore that is always underwater), where they are also common. The energy absorbed as light is trapped by the chlorophyll, which is also present in the cells, and used in photosynthesis.

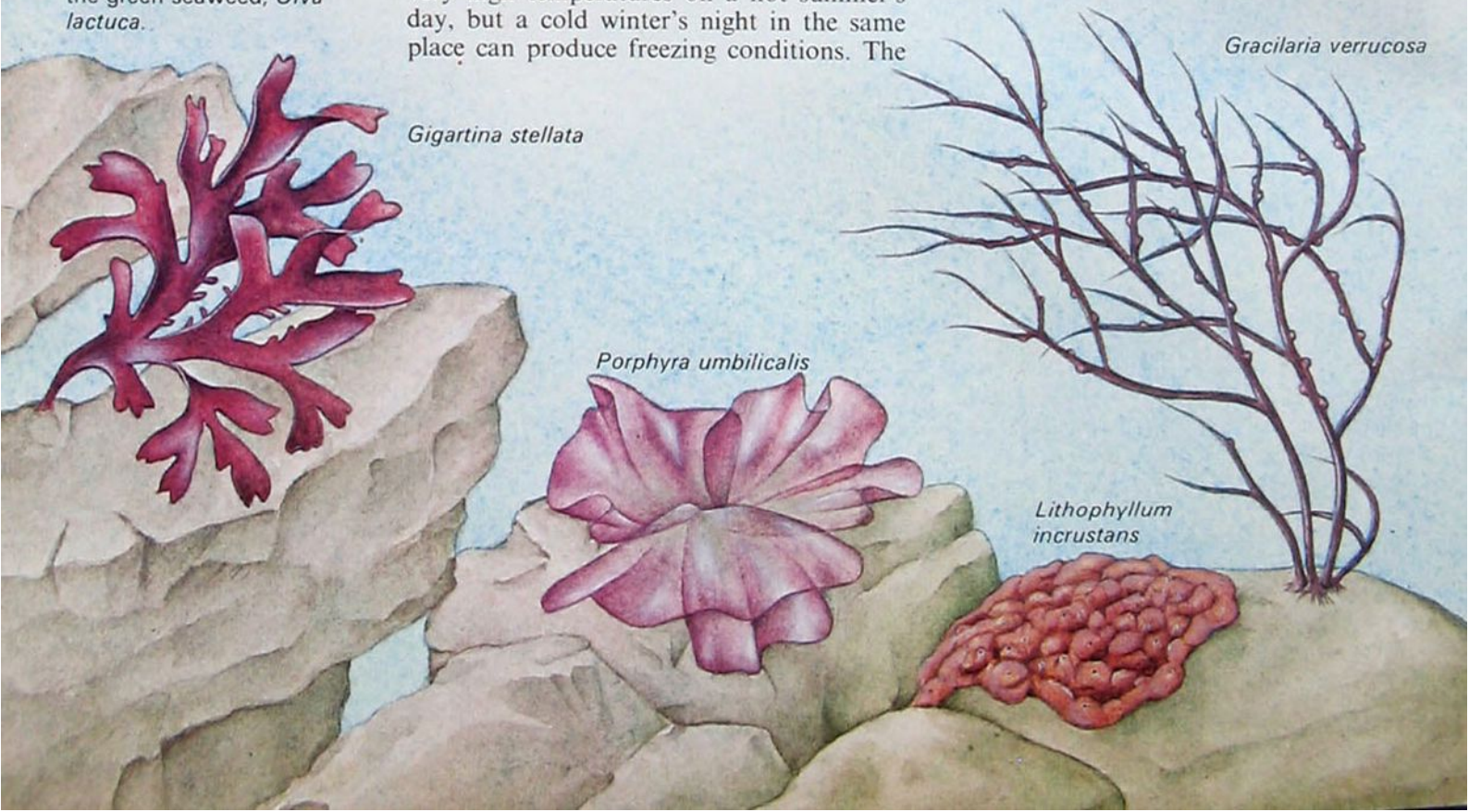
Problems of seashore life On the beach, one of the greatest threats to the algae is desiccation, a problem that rarely affects the red algae, as they always live in the water. Even so, if in shallow water they may dry out to some extent, especially on a hot day. Scientists have demonstrated that, as the thallus (the body of the alga) dries out, so the metabolic rate falls. The algae become dormant, in a way resembling desert animals that sleep through the heat of the day, thus conserving energy and water.

Temperature changes also present problems for the algae. A sheltered cove may have very high temperatures on a hot summer's day, but a cold winter's night in the same place can produce freezing conditions. The algae seem able to adapt to a specific range of temperature; but a degree or two outside this range may be lethal. Races or varieties of one species adapt to different temperature ranges and a race occurring in the north of Britain, for example, would not be able to survive in the Mediterranean.

Red algae are common throughout both mid-shore and low tide zones, and many of them extend into the sublittoral zone. But few are found on the higher levels of the beach, since they cannot survive strong light intensities. Living in such areas, they are also able to avoid desiccation and high temperature changes. Species of *Corallina* are so common in mid-shore or low tide level rock pools that these have been described as 'coralline pools'. However, even though such a pool may not dry out, a large proportion of the sea water present may evaporate in hot sunshine. In such a case, the salinity of the water increases dramatically and the algae employ complicated metabolic processes to maintain the correct osmotic (concentration of salt) balance within their cells, reversing the process when, in heavy rain, the salinity decreases.

Pools and reefs Coralline pools are very easy to spot, for the coralline species are quite distinctive; their thalli impregnated with calcium and magnesium salts, make them hard and brittle to the touch, and pink rather than red in colour. *Corallina officinalis* is common in rock pools or on rocks near the low water mark all round the coasts of the British Isles, sharing the southern and Irish coastlines with another species *Corallina squamata*, the two species being very difficult to tell apart.

Corallina is tufted in growth, but two more related species, *Lithophyllum incrustans* and

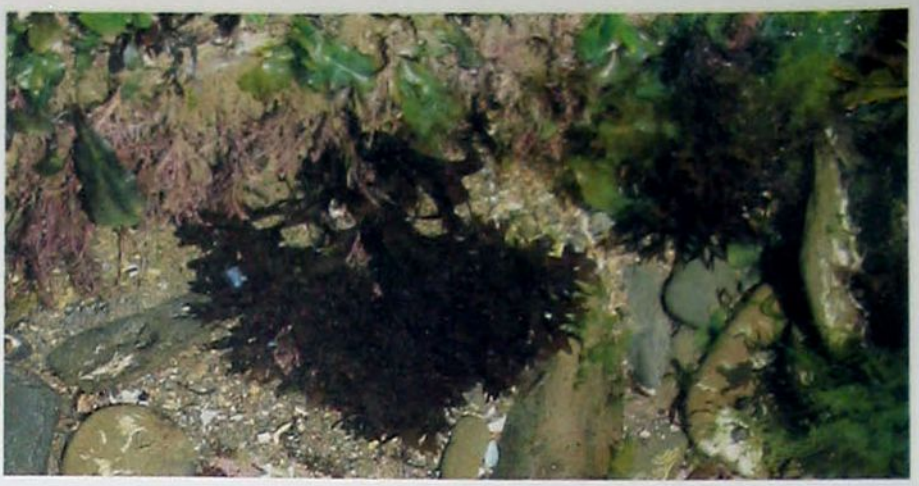


Phymatolithon lenormandii are encrusting species. *Lithophyllum* is found on rocks or seaweeds in sunny mid-shore pools whereas *Phymatolithon* grows in the crevices and shaded places of the pools. These two species are so common on certain beaches in Cornwall and the Hebrides that the sand may contain up to 40% lime, formed from the lime-impregnated fronds of the seaweeds. This lime-laden sand is used agriculturally, to improve acid soils.

In many parts of the world, including the sublittoral fringe of the western coasts of Britain, *Lithothamnion* species form large lumps and reefs, resembling those formed by the corals. In fact, it was not until the middle of the last century that scientists realised that these reefs were formed by algae and not true corals. Algal reefs are so extensive that in many areas, from the Arctic to the tropical seas they extend over the sea bed for several miles at a time.

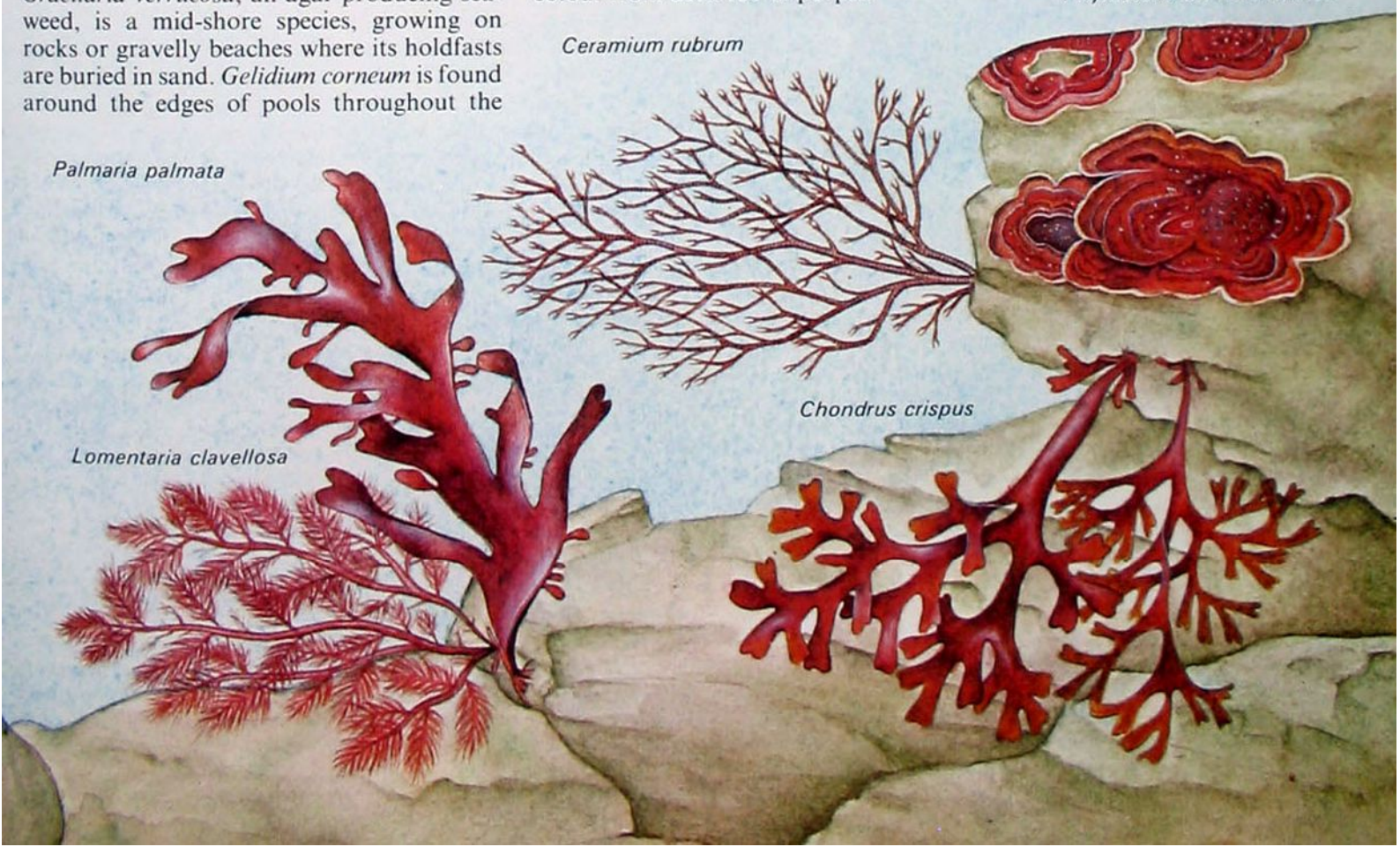
Floating seaweeds Not all the algal occupants of coralline pools are hard and crusty. Many of them are much more typical red algae – with soft, much-branched thalli, tufted in growth and attached to a rock or seaweed by a knob-like holdfast. *Ceramium rubrum*, common in mid-shore pools on rocky coastlines, is an example. This is one of the most common of the 24 British species of *Ceramium*, but the differences between them are really only identifiable under a microscope.

Lomentaria clavellosa is another common rock pool alga of the low tide level, along with *Chondrus crispus* (carragheen or Irish moss), and *Gigartina stellata*, which covers large areas of rocks with its branched fronds. *Gracilaria verrucosa*, an agar-producing seaweed, is a mid-shore species, growing on rocks or gravelly beaches where its holdfasts are buried in sand. *Gelidium corneum* is found around the edges of pools throughout the tidal zones on British beaches and is one of the few red algae that can withstand high-intensity light.



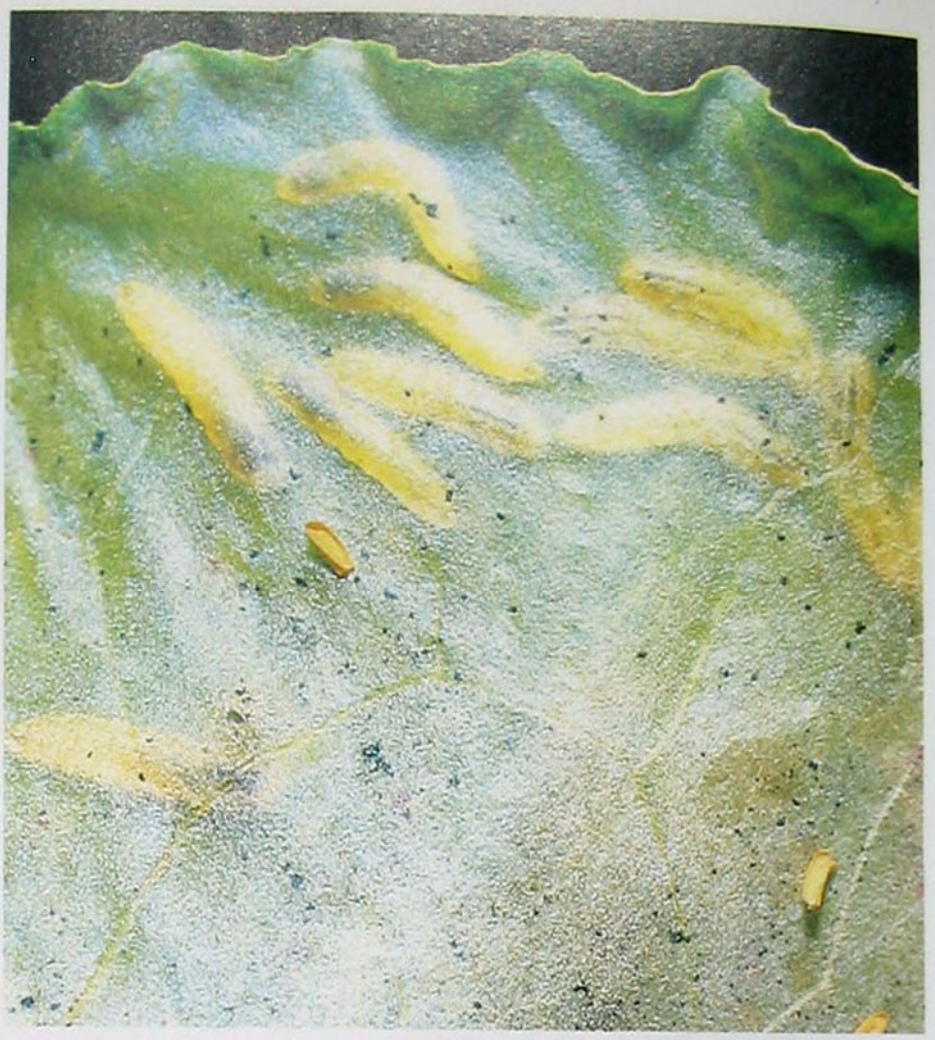
Porphyra umbilicalis (laver) is another of the few reds found throughout the tide zones. Although today very little direct use is made of algae as a food by western countries, this seaweed is considered a delicacy in Japan and China, where demand has far exceeded supply from natural sources and so it has had to be cultivated. *Palmaria palmata* (dulse) has also been used for human consumption in the past. Today, sheep are rather partial to it and seem to seek it out in the northern coastal areas of Scotland. It is found growing epiphytically on fronds of *Laminaria* in the low tide areas, as well as on rocks in the same zone. The stalk is almost absent and it is attached by a disc-like holdfast. One of the most common of the red seaweeds, it can be recognised by its thick lobed and branched fronds which vary in colour from dark red to purple.

Commercial uses
Before World War II, a Japanese species of red algae, *Gelidium amansii*, provided most of the world's agar, a substance used as a gelling agent and thickener in foods such as jams and jellies and in the cosmetic industry in lotions and ointments. During the war, Japanese agar was unavailable and alternatives had to be found. *Gigartina stellata* and *Chondrus crispus* were found to contain another gelling agent, carrageenan, in commercial quantities. Britain is now a major producer of this chemical, used as a stabiliser and thickener.



INSECT LIFE IN A LEAF

The pale blotches and wavy lines you find on many leaves are the tunnels, or mines, of tiny larval insects that make their homes between the upper and lower leaf surfaces.



A typical leaf is less than one millimetre thick and there is little room for any creature to move about between its upper and lower surfaces, but a large number of insects have been able to exploit this cramped space and its rich supply of food. These insects are the leaf miners. Most are moths and flies, although there are also some leaf-mining beetles and sawflies. All are, of course, very small insects.

The mines are always made by the larvae, most of which, through leading the same kind of life, have come to look very much alike. They tend to be colourless and legless, and the head tapers towards the front with the mouthparts right at the tip. The body is usually extremely flat–as you would expect of a creature living in a 'room' only a fraction of a millimetre high–although fly larvae are essentially cylindrical and merely become compressed as they tunnel through the leaf tissues.

Serpentine and blotch mines There are two main types of mine–the serpentine and the blotch. The serpentine mine is a sinuous tunnel which snakes its way through the leaf tissues. It is usually the work of a single larva and it generally gets progressively wider as the insect grows. Although it often starts near the edge of a leaf, the serpentine mine may begin at any point, but it rarely crosses the mid-rib of the leaf.

A blotch mine is formed when the larva excavates a relatively broad and often irregular area of the leaf. It may be the work of one or several larvae. Blotch mine occupants may make a little more room for themselves by spinning silken threads just inside the epidermis: the threads shrink as they dry and cause the surface to buckle, thus forming a slightly deeper chamber. Some species start off by making a linear mine and then gradually open it out to form a blotch. The beech leaf miner (*Rhynchaenus fagi*) is a good example. This is a small, greyish weevil and its larval mine begins near the mid-rib of the leaf and extends outwards to form the blotch close to the leaf margin.

Permanent and temporary homes Most leaf miners spend their entire larval life within a single mine, but some species mine only during their very early stages and then feed externally on the leaves. Most miners are unable to begin again once they have left their mines, but a number of species do leave their tunnels from time to time and begin new ones elsewhere–on the same leaf or on new leaves.

Pupation can take place inside the mine, although most species leave and pupate elsewhere. It is not always easy to see the hole through which a miner has left, but you can see if it is still at home by holding the leaf to the light. If the larva is still there, you may even be able to watch it feeding, relentlessly scraping away at the tissue.

Brambles and birches One of our commonest and most conspicuous leaf mines is that of the moth *Stigmella aurella*; the mines can be found on brambles almost everywhere. The serpentine mine shows up silvery grey or pale brown on the upper surface of the leaf. It normally starts as a thin tunnel near the edge of the leaf and is often very twisty in the early stages. The final length may be quite straight, often running alongside the mid-rib. The mines can be found at all times of the year, for the larva feeds through the winter. Prolonged frost kills it, however, so it is not found in places with severe winters. The adult moth has a wingspan of only 6mm ($\frac{1}{4}$in) but is beautifully patterned with purple and gold.

Adult leaf miners either lay their eggs on the surface of a leaf or insert them into the tissues; the larvae begin mining as soon as they hatch. If the eggs are laid on the leaf surface the grubs usually emerge from the base of the egg and go straight into the leaf. The rich photosynthetic tissues of the leaf provide abundant nourishment for the small leaf-mining grubs, (such as the fly larvae shown here). Some species chew their way through the upper layers, just under the upper skin, while others prefer the lower layers. The pale mine, indicating where the tissues have been removed, can be seen on either surface, according to the insect species that makes it. A few species mine the whole thickness of the leaf. The outer skin is usually left untouched, thus providing protection from desiccation and also from some enemies. Birds, however, frequently attack leaf mines and extract the insects, and parasites also take a heavy toll.

Birch leaves, especially those of young trees, are commonly mined by the larvae of another little moth called *Eriocrania semipurpurella*. Almost every leaf may be affected on small trees. The mine is a pale blotch and it is occupied from late March to May. The excrement, or frass, is bound up into long inter-twining threads, which immediately identify the mine as belonging to the *Eriocrania*. The insect spends the winter in the soil as a pupa.

Mining flies Few holly trees escape the attentions of *Phytomyza ilicis*, a tiny grey fly whose larvae produce yellowish blotch mines of a very irregular shape. These mines have a blister-like appearance. The insect is so abundant at times that more than a third of the leaves on a holly tree may be affected.

Dock leaves are commonly mined by flies of the genus *Pegomya*, of which *P. calyptrata* is a common example. The eggs are laid in batches and the larvae live communally in blotch mines, which are often so extensive that they link up and cover the whole leaf. The fully-grown larvae emerge through the shrivelled upper epidermis and pupate in the ground. The adults are like small houseflies, with a bluish-grey thorax and an orange abdomen.

The jerking disc sawfly The leaves of sycamore and field maple often bear the pale brown blotch mines of *Heterarthrus aceris*. There may be several mines in one leaf, usually towards the extremities, but there is just one larva to each mine. The larvae feed in June and July, and when fully grown each one cuts a perfectly circular disc from the upper epidermis. A sheet of silk is spun on the underside of the disc and the larva snuggles down in this envelope. The whole disc then falls from the leaf and the larva spends the next six months or so at rest.

It needs a moist, shady situation and so any larva whose disc falls into a dry place becomes restless and throws its body from one side of its case to the other. These movements cause the whole disc to jerk about and it eventually comes to rest in a suitable spot. The insect finally pupates in the envelope in the spring and the adult emerges in May.

Blotch mine (above) made in a holly leaf by the fly *Phytomyza ilicis,* and serpentine mine (right) made by the moth *Stigmella aurella.* Many trees and shrubs are attacked by leaf miners, but the mines seem to have little effect on their general well-being unless they are particularly numerous. Frass is no problem in a serpentine mine, for it is simply left behind as the insect tunnels forward. The trail of frass can, in fact, identify the mine. Blotch miners sometimes make small flap-like openings in the leaf surface through which they jettison the frass, but most species simply leave it in the centre as they mine outwards. Some even bind the frass into little parcels with silk.

Moth *Stigmella aurella*; larvae make serpentine mines in bramble leaves.

Jerking disc sawfly *Heterarthrus aceris*; larvae make blotch mines in sycamore.

Moth *Eriocrania semipurpurella*; larvae make pale blotch mines in leaves of birch.

Fly *Phytomyza ilicis*; larvae make blotch mines in holly leaves. Very abundant.

Fly *Pegomya calyptrata*; larvae make blotch mines in dock and live in extensive communities.

Weevil *Rhynchaenus fagi*; larva starts with serpentine mine, widening to blotch, in beech.

THE WILDLIFE IN OUR HOMES

An Englishman's home may be regarded as his castle, but it is invaded by many forms of wildlife that can be difficult to control. The presence of some of the species may seem surprising in what is for them often a hostile and alien environment.

Above: This interesting, if somewhat alarming, growth by the window of a derelict house is dry rot fungus (*Serpula lacrymans*) and rust spores.

Among the problems that wild creatures have to face when living in a house are drought, restricted daylight and constant disturbance, and the successful interlopers are those that have adapted to withstand such conditions. Carpet beetles, clothes moths and meal moths, for example, can survive quite happily without water, while most house pests are nocturnal and only become active when the household is asleep.

The fact that these intruders are present at all shows that houses do offer them some advantages–warmth, shelter and a plentiful food supply. If damp penetrates, then drought, one of the chief disadvantages, is eliminated and the way is opened for a wider range of plants and animals to take up residence.

Plant life is severely restricted by lack of water and suitable 'soil' in which to grow. The most successful plants to be found in the house are fungi, probably because they are not reliant on daylight for their survival. The notorious dry rot fungi attack and destroy only damp wood (contrary to their name), while moulds grow on damp wallpaper, newly plastered walls and food such as bread and cheese.

Green algae will grow on window surrounds where condensation provides sufficient moisture and also in the water of vases

and fish tanks where these receive sufficient daylight.

Insect invaders Moulds provide food for plaster and fungus beetles, while larvae of the death watch beetle and wood boring weevils can only eat wood that has been softened by fungi. The furniture beetle feeds on all kinds of wood in the home but can also survive quite happily out of doors in dead tree stumps and old hedges. Although the house longhorn beetle is probably an immigrant, as it seldom survives out of doors and only occurs in the south, its small population can cause large-scale damage: its larva bores large holes in beams and rafters and has even caused roofs to collapse.

Many small creatures are associated with man's food and have lived with man from the time he first began to store berries, grain and dried meat. Spider beetles, biscuit beetles, meal moths and flour mites feed on a wide range of stored foods of vegetable origin. Most of these are adapted to survive with little or no moisture, although flour mites require damp food. Larder beetles feed on carrion in the wild, but readily eat scraps of meat and cheese and will even attack fur coats.

The warmth-loving cockroach and house cricket are scavengers and will eat food left out overnight. The house cricket was at one time tolerated in houses and the cheerful chirping of the 'cricket on the hearth' was a welcome sign of life on cold winter evenings.

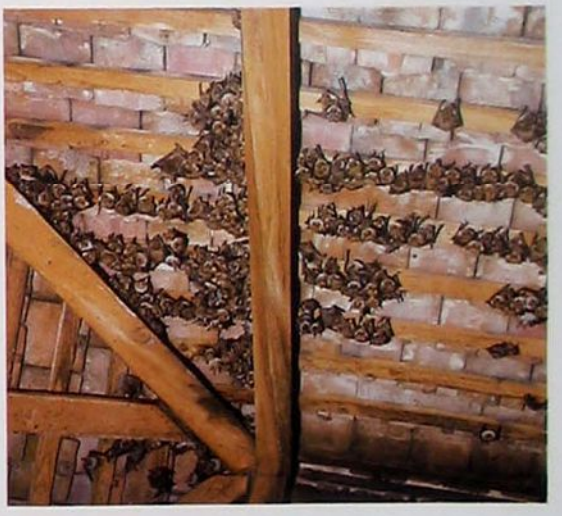
Mice and rats, on the other hand, have always been unwelcome and can cause extensive damage in the larder, gnawing through packages and soiling food with their droppings. Houseflies and bluebottles are similarly unwelcome because they feed on carrion outside and spread disease when they settle on our food. Wasps and ants are particularly attracted to meat and sugary foods in summer, while fruit flies like fermenting fruit and alcoholic drinks.

Carpets and fabrics provide food for the larvae of clothes moths, house-moths and carpet beetles. In the wild these creatures scavenge the nests and burrows of birds and mammals, but have also adapted to life in the home. Silverfish are primitive insects that feed on a wide range of plant and animal matter and are also prolific indoor scavengers. They seldom cause serious damage, but do indicate the presence of damp. The related firebrat prefers hot dry situations and is mostly found in such places as bakeries and large kitchens. Another scavenger is the house dust mite, which feeds on human skin scales shed among bedding and furniture and produces a dust that can affect asthma and hay fever sufferers.

Lofty intruders The attic, one of the least disturbed places in the house, may harbour a varied fauna. A number of birds have forsaken their natural nesting places for the eaves or rafters. Swifts, swallows and, to some extent, house martins now rely on houses for nesting sites. Starlings, house sparrows and pigeons frequently nest in roof spaces and the moths, beetles, fleas and mites associated with them can also be a considerable nuisance. Other aerial intruders include wasps and bees, which build their papery nests in the attic and in turn provide homes for such creatures as the brown house-moth.

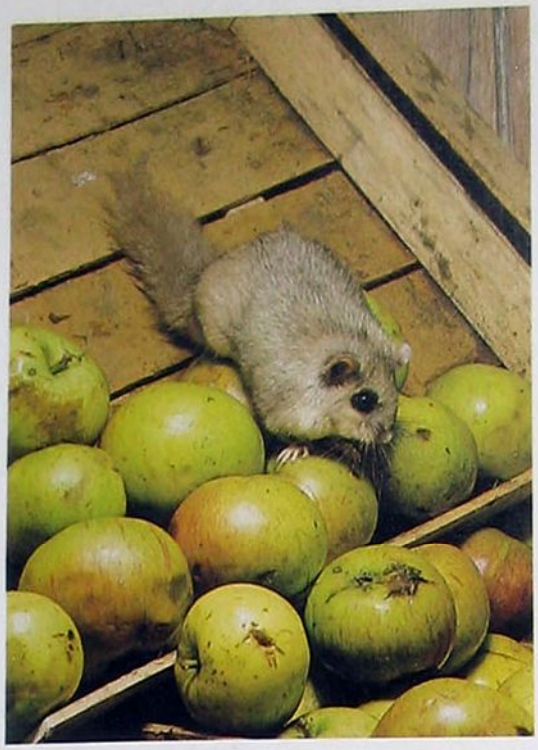
House mice are common inhabitants in attics and at one time the black rat was also found here, although it has been ousted by the brown rat, a less nimble creature that seldom climbs very high. The edible dormouse is also found here. Bats sometimes take up residence

Above: Cockroaches enjoy the warmth of a house and make the most of food left out as they scavenge at night. This is an American cockroach (*Periplaneta americana*); this species is about 3cm ($1\frac{1}{4}$in) long. During the day, cockroaches hide in out-of-the-way places such as under floors, behind skirting boards and in ventilation ducts.



Right: More than a hundred bats roosting under the roof of a house. Bats roost during the day in almost any place that is protected from direct sunlight; but most are found in buildings and hollow trees, while some hibernate in caves.

Below: Silverfish (*Lepisma saccharina*) like damp conditions, but will also raid food cupboards and feed on paper, the glue on cartons, and flour. They are up to 2cm ($\frac{3}{4}$in) long.



Left: First introduced to Hertfordshire at the turn of the century, the edible dormouse (*Sciurus glis*) is particularly fond of raiding apple stores. At one time this attractive little mammal was considered a culinary delicacy by the Romans.

Below: Quite a common sight under the eaves of house roofs is the house martin's nest. The bird is some builder, as you can see by the way this nest has been constructed. Here it's feeding time for the new brood.

in roof spaces, particularly in the winter when they leave their natural roosts in caves and hollow trees for the warmth and security of man's dwellings.

Lowly residents Cellars are interesting habitats for wildlife since they tend to be damp and are often left undisturbed for long periods. The brown rat frequently takes up residence here, finding its way in via broken sewers and drains. The house mouse is also at home here, particularly in the winter months; in country areas it may be replaced by either the wood mouse or the yellow-necked mouse. In very damp cellars, toads have been known to thrive and, where sufficient light filters in, ferns have become established. A curious inhabitant of the wine cellar is the small yellow V-moth, whose larvae feed on the mouldy corks of wine bottles, sometimes to the detriment of the contents.

The parasites Of all the household pests, those causing the most alarm are the parasites. The human flea is still to be found in Britain, mainly in slum areas of large cities. The most common fleas are cat fleas, which are equally at home on dogs and will also bite humans. Bird fleas migrate from nests in the roof and may also bite humans, although they cannot survive long away from their natural hosts.

While body and crab lice are less common now in Britain thanks to improved hygiene, head lice are increasingly found, particularly among young children. The entire life cycle takes place on the hair so that transmission of the parasites is by direct contact. Bedbugs are fortunately on the decline; these hide by day in crevices and behind loose wallpaper, emerging at night to seek a human host.

Predators in the home are few. The most common are the much maligned house spiders, which prey on insects and other invertebrates. They usually spin their untidy webs in the corners of rooms, under the eaves or in crevices and can survive equally well outside. Those found running across the floor or trapped in the bath are usually casual visitors driven in by the cold or wet.

Changing environment As homes have developed through the ages, so their wildlife has changed. Since at one time most houses were made entirely of wood, it is not surprising that wood-feeding organisms were great home-lovers. With the advent of insecticides and preservatives and the gradual replacement of wood by metal and plastic, however, they are becoming progressively more scarce. Similarly clothes moths are less common since nylon and other synthetic fibres have largely replaced wool. Improved standards of hygiene have played their part, too, and the vacuum cleaner has proved to be a deadly enemy of many indoor creatures, removing the dust and debris in which they breed.

The introduction of central heating has also had a profound effect on the fauna of houses since many species cannot tolerate the resulting low levels of humidity. On the other hand, some of the warmth-loving species thrive under these conditions. The increasing popularity of houseplants, too, gives scope to a whole new range of wildlife in the shape of greenfly, thrips and similar insects.

WADERS OF THE WOODLANDS

Bird watchers who know the woodcock as a shy retiring woodland bird are often surprised to learn that it is a wader, closely related to shore birds such as the curlew and sandpipers. The similarity is seen most clearly in its long probing beak.

Below: A female woodcock at her nest. Woodcocks seek out dry sites for their nests, preferably among leaf litter near the base of a tree trunk. The nest is often a simple hollow scraped out of the ground.

The ideal habitat for a woodcock is a deciduous wood with plenty of leaf litter. The wood needs to have some dry areas where the woodcock can nest, and some wet areas for feeding – typically a patch of ground kept perpetually moist by seepage from an underground spring and rich in worms, the woodcock's major food source. Besides this mixture of wet and dry ground, woodcocks require a broken canopy and preferably also open glades for their display flights.

Despite having such particular requirements, the woodcock is widespread throughout both Britain and Ireland – more so than most bird watchers would imagine, as its secretive habits often keep it from view. In the breeding season it is absent only from the extreme south-west of England, the west of Wales and the northern isles of Scotland. In the south of England it is usually found in oak woods. Further north it is more likely to be seen in birch scrub (in Scotland) and in mixed plantations of deciduous and coniferous trees.

Judging from old records, the woodcock used not to be so widely distributed. Before about 1800 it was known to breed only in parts of England. One possible reason for this expansion is thought to be the increasing amount of commercial woodland being planted. Another factor might well be the

Above: Although the woodcock needs a dry site to nest on, it feeds in damp areas, probing the soil with its flexible beak to a depth of 8cm (3in) in search of worms and insect larvae such as leatherjackets.

Right: A typical clutch contains four eggs, coloured off-white to buff with brown markings for camouflage. They are laid at intervals of 2–3 days and incubated for three weeks by the female.

Woodcock (*Scolopax rusticola*). Native resident, found in woodlands in most areas of the British Isles. Length 34cm (13½in), including its 8cm (3in) beak.

increase in pheasant shooting. The associated management of woodland for game rearing produces conditions well suited to the woodcock.

Like pheasants, the woodcock is a popular game bird and in many areas special shoots are organised during the winter.

Sedentary birds Ringing recoveries indicate that most woodcocks breeding in this country are relatively sedentary, moving only a few miles within their neighbourhoods. Some, particularly those from Scotland and northern England, move south or south-west to avoid the winter, sometimes travelling as far as France, Spain or Portugal.

Conversely, each autumn, large numbers of woodcock arrive in Britain from parts of the Continent that have severe winters, such as Russia, Scandinavia, Germany and Holland. In these countries, the ground can freeze for long periods and prevent the woodcock from feeding.

Effective camouflage The mottled rich brown plumage of a woodcock provides it with ideal camouflage against a background of dead leaves or bracken and makes the bird extremely difficult to spot. If you approach a woodcock it crouches down, completely immobile. Only when you come within a few feet (sometimes just a few inches) of it does it take off.

Once you do spot a woodcock, however, it is an easy bird to identify. The only other bird you are likely to confuse it with is the snipe. Like the snipe, the woodcock has a disproportionately long beak and its colouring is similar, though the snipe has pale bars on its head running from front to back, whereas on the woodcock they run from side to side. The woodcock also has much larger eyes, which it needs to help it feed and fly in the late evening. These eyes make the woodcock's head seem larger and more angular than that of the snipe. Another difference is in the way that they fly. The snipe is a swift and nimble flier. The woodcock, on the other hand, has a much heavier appearance and a strange, jinking flight that makes it a challenging target for a marksman. This partly explains its attraction as a game bird.

Sensitive beak The woodcock feeds by probing the wet soil for earthworms and insect larvae, though there are records of its eating seeds and other vegetable matter. To help it feed, its beak has a swollen tip containing numerous sensitive nerve endings that allow the woodcock to identify its prey.

Another adaptation allows the woodcock to avoid eating large amounts of mud with each creature. The top half of its beak is supported by long nasal bones, which are in turn attached to the skull. In most birds these bones are held rigid, but in the woodcock they are flexible. Special muscles can pull them back, allowing just the tip of the beak to open so it can grasp the worm but leave any mud behind.

Patrolling the glades During the breeding season male woodcocks perform a strange display flight known as roding. Usually a single woodcock, but sometimes two or three, patrol a lengthy but regular circuit across the open glades of the woodland, either at dusk or at dawn. As it flies it gives out a triple croak more reminiscent of a frog, followed immediately by a whistling 'tsiwick'. The wingbeats are very slow and owl-like, and belie the real speed of the bird.

Roding seems to be the only activity in which woodcocks are at all gregarious. For much of the year they are the most solitary of all the waders.

Simple nests The breeding season begins early in March with the building of the nest. This is usually a simple affair, a hole scraped in the ground, often among leaf litter, and lined with leaves. The nests are frequently close to the base of a tree.

As with so many waders, the typical clutch size is four, occasionally three or five. The eggs have a background colour of off-white to buff, with variable brown or red-brown markings making them nearly invisible against the woodland floor.

The female alone seems to incubate the eggs. Once hatched, the chicks' eyes are quickly open and within a few hours their camouflage-patterned down is dry enough for them to leave the nest on short forays. Although initially short-beaked they feed themselves from birth, under the watchful eye of the mother.

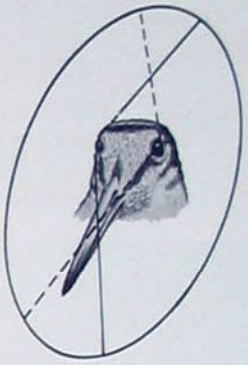
Do woodcocks carry their young? From time to time over a great many years bird watchers have reported seeing a woodcock in flight carrying a young chick between its legs. Whether or not this really happens has been debated among ornithologists for more than a century without settling the question.

The proponents argue that young chicks are sometimes found wandering with their parents a considerable distance from the nest. To get them there, or take them back, they have to be carried occasionally by one of the parents. It is thought that the adult clasps the chicks between its legs, holding them in place by depressing its tail and sometimes using its beak as well.

Sceptics say that what these people are seeing is simply a distraction display flight, a practice performed by many other waders to draw predators away from the young chicks. In the case of the woodcock, the flight is laboured and clumsy, the tail is held depressed and the beak droops. These flights usually end in a crash-landing, just as if the woodcock had been carrying a heavy burden.

There are now so many sightings of this phenomenon on record that most bird watchers have come to accept that it does occur, though rarely. But until someone can photograph it happening the question will remain open.

Below: The eyes of a woodcock are placed high up and on the sides of its head to allow it a complete 360° field of vision. With this, it can watch out for potential danger while probing deep into the soil for food.



Below: Woodcock chicks in their nest. The young are quick to develop. Within a few hours of hatching they are capable of leaving the nest under their mother's guard for short journeys in search of food. At 15–20 days old they begin to make short flights. About three weeks later they become independent.

SUCCESS AND THE SITKA SPRUCE

Introduced here from the New World during the last century, the Sitka spruce is now our most important source of timber. Huge plantations have been established in the previously neglected uplands of Scotland, Wales and the north of England.

The Sitka spruce was discovered growing on the west coast of North America by the great botanist-explorer, David Douglas. He introduced it to this country in 1831, but it was never popular as an ornamental tree. Apart from its sharp spiky foliage, which can be painful to handle, it has the unsightly habit of retaining its inner branches and twigs when they die.

For many years the Sitka spruce remained neglected as people failed to realise its potential as a commercial source of timber. Then, during the First World War, it became important as a source of timber for the newly emerging aircraft industry. Since then, it has been planted by the million and is now our

most valuable commercial conifer.

Fast growers In its native forests a Sitka spruce can grow as high as 80m (270ft). In the British Isles, however, the tallest specimens are about 50m (165ft) high, though, considering that none of these is much older than 150 years, this indicates an unusually fast rate of growth. Indeed, one specimen in Somerset grew to 42m (138ft) in its first 47 years.

The leaves of a Sitka spruce are flat, stiff and sharply pointed. Like the leaves of the Norway spruce, they grow on pegs that remain attached to the twig when the leaves fall.

The young cones are not easily seen. The male cones are small, about 2.5cm (1in) long, yellow, and occur only sporadically on the tree. The female cones are more abundant but are confined to the topmost shoots. When unfertilised, they are pale red and 2-5cm (1-2in) long. Each one contains numerous thin hard scales. When ripe, these open up to release tiny winged seeds, 3mm long.

Upland plantations Sitka spruce grows particularly well on damp, even peaty, soils, and it tolerates exposed conditions better than most other trees. This tolerance partly explains its popularity as a commercial tree. Much of the land acquired by the Forestry Commission during its existence has been in the uplands of Scotland, Wales and the north of England. On such exposed sites the Sitka spruce gives a greater yield of timber than any other tree.

Easily worked timber Another reason for the commercial importance of this tree is the quality of its timber. Although it lacks durability outdoors and is only moderately strong, Sitka wood is easy to work and takes glue and nails well. This makes it ideal for flooring, roofing and other interior construction work, for cases and boxes, chipboard, plywood and many other uses. As a source of pulp for papermaking it is unsurpassed. Its fibres mat together to form a strong yet smooth product and, because the wood is so pale, little or no bleaching is necessary.

Much maligned Despite their importance, plantations of Sitka spruce are widely disliked, mainly because of the way older plantations were laid out. Until about 15 years ago the most common method was to plant in straight lines down a hill, with little thought being given to how this would harmonise with the surrounding landscape.

Today, plantations are laid out to follow the contours of the hills, and the monotony of rows of identical Sitkas is being broken up by the occasional planting of other trees, both evergreen and deciduous.

Another improvement is that trees are now being planted further apart and thinned out properly. The resulting trees are sturdier and faster growing. As they continue to mature and be thinned out, so more and more light and air will enter the forests, making them increasingly attractive to both man and wildlife.

Above: Bright green spring growth of new leaves, still showing the brown bud scales. Older leaves are duller green above and pale blue-grey beneath.

Right: The bark of a Sitka spruce readily breaks into scales and separates from the trunk.

Left: **Sitka spruce** (*Picea sitchensis*). Introduced evergreen, native to north-west America. Height to 50m (165ft). Grows well on a wide range of damp soils.

Below: A plantation of Sitka spruce. Notice how the trees retain their dead lower branches as they grow.

ANIMALS OF THE LEAF LITTER

Leaf litter is a world of living things, a place of dampness and darkness inhabited by a host of insects, arachnids, mites and other animals. Here we look at those dwellers in the debris of the woodland floor that are easily visible.

Above: *Amaurobius terrestris* in her woodland lair. You can often hear the rustling sound this, and other, spiders make as they run over dry leaves. You may be lucky enough to see them, but you will have to look very closely—their brown colouring camouflages them well and protects them from such predators as birds.

Look at the debris on the floor of a well developed piece of mixed deciduous woodland containing oak, hazel and birch, with perhaps a little rowan and sycamore. In such a wood, on a medium loamy soil with reasonable drainage and no waterlogging, and with not too much disturbance, you stand a good chance of finding a rich and fascinating assemblage of animals.

The upper few centimetres of the woodland floor contain the most recently accumulated leaves, most of them still easily identifiable. This is the litter layer. The layer, or horizon, below has much more compacted leaves, bits of which are still recognisable, but most of which are already rotting. This fermenting layer, as it is called, may be several centimetres thick. Under it is a dark brown or blackish horizon—the humus—consisting of fully rotted plant, and some animal, remains. The distinction between the mineral soil and the three organic layers above it is sometimes blurred by plant roots and bits of twigs and stones.

Normally the three layers of the leaf litter harbour most of the visible plant life, but this area is also inhabited by millions of microscopic organisms—bacteria, one-celled animals, plants and fungal threads. These are the living things you cannot see, except with the help of a microscope. Here we describe some of the animals you can see with the naked eye.

Types of leaf litter The soil below leaf litter, and the trees above it, are both important factors in determining what kind of life can live within it. A well drained sandy soil is drier than one with a lot of clay, and is often acid, harbouring little wildlife in or on it. Under Scots pine on heathlands, for example, the needles may take up to nine years to decay because the acidity prevents the rotting agents, chiefly fungi, from doing their job properly. But a chalky soil, on the other hand, favours rapid bacterial action, and a great number of small animals can live in it.

The types of leaves are also important. The needles that drop from most conifers give a rather acid kind of humus, but oak, ash and sycamore leaves produce a much less acid

medium. Beech, however, which favours a chalky soil, gives a rather acid humus, especially if it accumulates in large masses. However, if it is mixed with the top layers of soil and contains some chalk, it then forms a moister, better rotted type of humus.

Leaf litter hunters You can usually find a fair number of brown spiders of the Lycosidae family (hunting or wolf spiders) in leaf litter. They do not make webs, instead running down their prey by speed alone. They are often numerous on the floors of drier woodlands, and on warm days can be heard running about over the leaves. Some small web-spinning spiders also make their home in woodland leaf litter.

Only a few species of harvest spiders (harvestmen or Opiliones)–also arachnids–live in litter. *Oligolophus tridens* is one of the commonest and can be recognised by its dark brown body-saddle, sharply cut off at the back. Under the litter and among the humus, close to the earth, are two or three other species–all with the short legs that are an adaptation to the habitat. Harvest spiders are mainly carnivorous and feed on any small creatures they can capture, or on freshly dead bodies and animal droppings.

Multitudinous mites There is normally a vast population of mites in leaf litter. Most are visible to the naked eye, but young ones are extremely small. They live throughout all the organic layers. Many feed on fallen leaves and plant debris and thus initiate the process of decay. In this they are helped by the springtails (see below). The process is finished by bacteria and fungi, by which time the material has been covered by new leaf fall and is approaching the state of humus. Eventually, chemical plant foods are released from this decayed matter into the mineral soil and taken up again by plant roots. This recycling is vital to the economy and successful functioning of the ecosystem.

Leaf litter insects Only a small number of our insect species are true litter dwellers, but one or two kinds can be very numerous there. Among these are some of the most primitive and least known of all the insects, none of

Above: Red soil mite. Vast populations of these animals live in leaf litter and feed on fallen leaves.

Below: Leaf litter appears everywhere on the woodland floor, even during the summer when the leaf fall from the previous autumn has not yet rotted. You also find it at the bottom of hedgerows, under scrub, and even in the proximity of rivers where it has been brought down as flood debris.

Bristletail. Blind white insect; reaches a length of about 6–8mm ($\frac{2}{8}$–$\frac{3}{8}$in).

Proturan. Feeds on dead and decaying plant remains. Very small at a length of 1–1.5mm.

Springtail. Lives in upper part of leaf litter and reaches no more than about 5mm ($\frac{2}{8}$in) in length.

them having wings or undergoing complete metamorphosis. They are the springtails (Collembola), proturans (Protura), two-pronged bristle-tails (Diplura) and three-pronged bristle-tails (Thysanura).

Springtails, living in the upper part of the leaf litter, are very active insects, rarely more than 5mm (¾in) long and with grey or yellowish hairy bodies. At the end of its body a springtail bears a forked tail usually held underneath the abdomen by a small hook. When this tail is released and suddenly moved downwards and backwards, the insect springs vigorously forward – hence its common name. Springtails also have long antennae. They eat fallen plant material on the woodland floor.

Proturans are minute, pale, 1-1.5mm long insects that have no antennae. Their forelegs are held upwards and forwards and perform the same sensory functions as the antennae of other insects. The Diplura, or two-pronged bristle-tails, are also small, normally only 6-8mm long. They are white with long antennae but no eyes. The Thysanura, or three-pronged bristle-tails, have long antennae, compound eyes and scaly bodies. These three latter groups are thought to be mostly saprophytic in habit. That is, they feed on dead and decaying plant remains.

Beetles are also found in leaf litter. Some, like the pine weevil, use this habitat as a hibernating place, as do some ladybirds. Ground beetles and rove beetles, on the other hand, are permanent residents. Some are carnivorous while others feed on decaying plant remains or on roots and fruits. One of the most conspicuous carnivores is the violet ground beetle which is 22-28mm (about 1in) long and dark violet-black. This insect is also frequently seen in gardens.

Above: Ground beetles such as *Loricera pilicornis* are permanent inhabitants of leaf litter. This one is feeding on a lobworm.

Right: Wolf spider *Lycosa lugubris*. These spiders are extremely numerous on the woodland floor and are carnivorous, running down their prey at high speed.

Below: Longhorn beetle *Rhagium bifasciatum*. The larvae of this beetle feed on wood, while the adults exist on nectar.

Flies, and especially their legless larvae, frequently appear in leaf litter. Most are very small and live in the damper parts, usually in the less acid types of leaf litter. They are an important part of the food of such predators as beetles and centipedes.

Other litter dwellers Woodlice, despite their name, normally have little association with wood; they feed on leaf litter, seedlings, fungi and occasionally dung, and are decomposers helping, along with millipedes and other organisms, to break down dead plant remains.

Millipedes, familiar as long-bodied, many-legged creatures, also make their homes in leaf litter. They are exclusively vegetarian and most species probably prefer living to dead plant material. Centipedes, on the other hand, are carnivorous and eat any living creature they can catch. Neither they, nor the woodlice and millipedes, have a waxy layer in their skins as true insects do and so they are liable to dry up. They must therefore remain in fairly moist places, emerging only at night when the air is damper.

WINTER TRACKS AND SIGNS

Mammals are, on the whole, secretive creatures. Often, the best evidence of their existence comes from tracks and trails; these are especially easy to spot in winter.

Above: A fox foraging in the snow for food. The tracks it makes are similar to those made by a dog, but the pad marks of a dog are closer together, giving a more compact track. This fox is probably creeping along on the scent of a small rodent.

Winter is an excellent time of year to look for signs of a mammal's activity, especially after a fall of snow on a windless day. In snow which is a couple of centimetres thick and hardened by frost, tracks are clean and sharp. Most mammals stay hidden during the worst of the weather, but once it has improved there is a lot of feeding activity and footprints are made in many places.

Imprints also show up well in mud and sand. Damp, slightly muddy earth by a woodland path, a ditch in a forest or a hedgerow are good places to look for tracks. The wet sand on a beach at low tide or even the damp sand on the dunes are other surfaces where you can expect to see clear trails.

It is as well to know what mammals are about during the winter and therefore what tracks to expect to see. The dormouse hibernates during the cold months, and so does the hedgehog, although it is a lighter sleeper–it wakes only when it is relatively warm so it is not about when snow is on the ground. Weasels tend to make tunnels and holes in thick snow rather than travel over it. The tracks of the small lightweight stoat are usually indistinct as the foot pads are covered with hair.

Rabbit and hare tracks are commonly seen during winter. They are quite similar in appearance except that the hare's are slightly larger and more widely spaced out. It is easy to tell the two apart, however, with the aid of a standard matchbox. The width of a hare's track is about the width of the box whereas a rabbit's track is only two thirds the width of a matchbox and much less than the length.

Below: Stoat prints in wet, muddy sand at the edge of a lagoon near Southwold, Suffolk. The closeness of its prints suggests that the mammal was running.

Badger footprints are quite distinct. This animal moves with a heavy tread, the hind foot usually registering in the print of the forefoot. The large tracks are square in shape with a very broad heel pad.

Deer slots Identification of individual slots is based mainly on size. The largest are made by the red deer stags which have footprints 8cm (3in) long. Next in size is the fallow deer buck with slots 7cm ($2\frac{3}{4}$in) long, then the sika with prints 6.5cm ($2\frac{1}{4}$in), the roe 4cm ($1\frac{1}{2}$in) and finally the muntjac slots which are 3cm ($1\frac{1}{4}$in) long. It must be remembered that male slots are proportionately larger than those of females.

Caches of nut shells are give-away clues to the presence of small mammals–hazelnuts being the favourite food of many. Their thick hard shells make them difficult to deal with but each animal has its own particular way of tackling the problem and in doing so leaves individual toothmarks on the smooth brown shells.

Mice and voles gnaw a hole in the shell to get at the kernel inside. Lodging their upper incisors in a part of the shell that is slightly rough they are able to gnaw with the lower incisors. The wood mouse gnaws in such a way that it leaves an untidy hole with tooth-

Above: Tell-tale footprints to and from an opening identify the sett of a badger. This mammal does not hibernate, but will stay in its sett in very cold weather for days without eating. In milder periods it leaves its sett at night to search for food.

Naming footprints

Several terms are used to describe the different types of mammal footprints.

Track refers to a single footprint in the ground, or two if they have registered.

Trail means a pattern or succession of tracks left by a moving mammal.

Registering is when the tracks of the hind feet almost, or completely, overlap those of the forefeet.

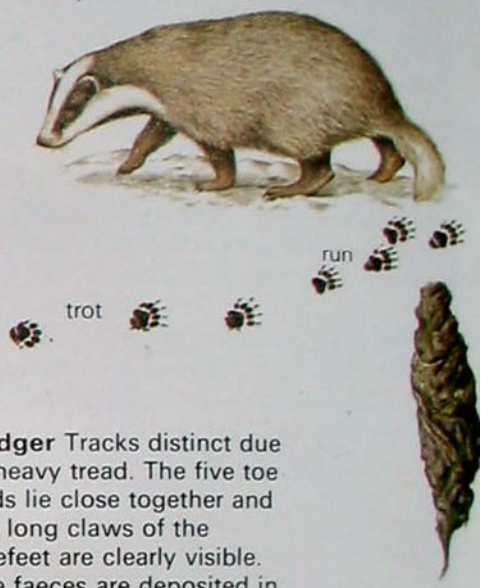
Slot is the individual footprint of a deer.

Cleaves are the two halves of a cloven hoof.

Splaying is the term used when the cleaves spread out in soft ground.

Signs of life

Most of our mammals are shy creatures and are not often seen during the day. Evidence of their whereabouts, habits and homes are usually betrayed by their tracks, trails and other signs, such as droppings, that they leave behind after a night's activity. Winter is a good time to search for these signs since snow, mud and damp ground show up clear trails and footprints very clearly.



Badger Tracks distinct due to heavy tread. The five toe pads lie close together and the long claws of the forefeet are clearly visible. The faeces are deposited in specially dug latrine holes.

marks both on the inside and outside of the shell whereas the bank vole leaves a shell with holes that have toothmarks on the inside only.

The squirrel splits the shell lengthwise into two clean halves. First it holds the nut with its forefeet and gnaws a groove across the top to make a small hole. Putting its lower incisors into the hole it presses the nut down until it cracks open.

Pine cones are another favourite food of these same mammals. Cones stripped with a frayed base and left lying out in the open are the work of squirrels. Cones stripped by mice and voles are left with a smooth, round base. They are less likely to be found as these animals drag the cones into the safety of their underground runs to eat.

Bark, twigs and buds are important sources of food for mammals during the winter, especially deer. These relatively large mammals leave quite noticeable feeding signs on trees. Deer have no upper jaw incisors, so that they tend to break or tear off, rather than bite, shoots and twigs leaving frayed, uneven ends behind. When deer attack a tree it is said they 'bark' the tree. They strip the bark upwards with their bottom incisors leaving long bare patches of trunk. Usually a mature tree is barked on one side only and does not die. Young trees, however, may suffer so much damage that they do not recover. Considerable damage is also done to young trees by the bark-gnawing activities of voles in winter.

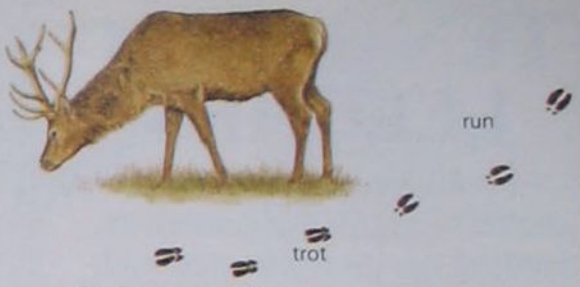
Mammal droppings are very informative clues to an animal's life. Each individual species tends to produce its own characteristic droppings. The plant-eaters eat large quantities of food to obtain sufficient nourishment. As a result they make frequent droppings that are usually small and round. The flesh-eaters do not eat in such quantity, as a small amount of meat gives lots of nourishment and energy. They produce fewer faeces and these are often cylindrical with a point at one end. Some mammals such as rabbits drop their faeces at random while others such as the badger and fox use special latrines.

Heaps of rabbit droppings are often found on ant hills and mole hills where they are used to mark out territory. The droppings are about 10mm ($\frac{3}{8}$in) in diameter. The hare's are slightly larger, 15-20mm ($\frac{3}{4}$in) in diameter, and are pale brown or yellow-brown in winter. They are often found in small piles a short distance away from the hare's form. Squirrels leave dark brown or black droppings in the winter. They are quite short, less than 5mm ($\frac{3}{16}$in) long, almost spherical with one flattened and one pointed end.

Deer droppings are called fewmets. They are usually short, black and cylindrical often with a small point at one end. They are usually deposited in quite large heaps or clusters at the feeding places. The roe deer often defaecates while it is moving so the droppings are scattered along its trail.

Grey squirrel The four long, slender, clawed toes of the forefeet are clearly seen. The tiny thumb does not register. Squirrel droppings are rather scattered.

Red deer When walking or gently trotting, the hind foot registers in the forefoot track. Stag's track larger than doe's. Stag's droppings concave at one end, doe's rounded.



Wood mouse Nearly impossible to distinguish tracks of different mice. Habitat, feeding signs, small, scattered droppings are clues to identify species.

Red fox Tracks easily confused with those of dog of similar size, but fox pad marks are smaller and not so close together. Droppings are black if the fox has eaten berries, white if it has eaten bones.

Roe deer Hooves leave narrow, pointed impression. Dew claws register only if deer gallops or jumps. Droppings found at feeding places and along trails.

The badger scrapes out a special latrine–often near its sett–about 10cm (4in) deep in which to deposit its droppings. It does not cover it over after use, but uses it time and again. The faeces may be either like those of the fox or semi-liquid, depending on what the animal has been eating.

Fox faeces are like those of a dog but smaller, usually 8-10cm ($3\frac{1}{2}$-4in) long. They are cylindrical and have one end twisted into a point. They vary in colour from black to grey and often contain the bones of small mammals and birds.

Scent marking is used by many mammals as a way of claiming their territory or of keeping a pair together. Our sense of smell is poorly developed and we are unlikely to detect these signals.

Within their home territories the mammals lead regular and well-organised lives. Each tends to have a system of well-worn paths and runways between home and feeding ground and these are clearly seen in winter when the ground cover is less dense. Other signs to look for are the homes themselves. The mole's hills are unmistakable, and so too is the sett of a badger. Freshly trodden earth around the sett entrance means it is inhabited. Lack of spiders' webs across the mouth of the hole also means that the animals are coming and going frequently. Steam rising from the entrance on a cold winter morning is proof that the badger is at home.

Right: Tree damage caused by a fallow deer in the New Forest during its rutting season. The bark is completely stripped, so this young pine tree will not recover.

Below: Squirrel 'table'. Both the grey and red squirrel feed on pine cones. An unstripped cone is taken to a favoured feeding place, such as a tree stump, and the scales are gnawed off one by one so that the squirrel can obtain the seeds lodged inside.

TENACIOUS LEECHES

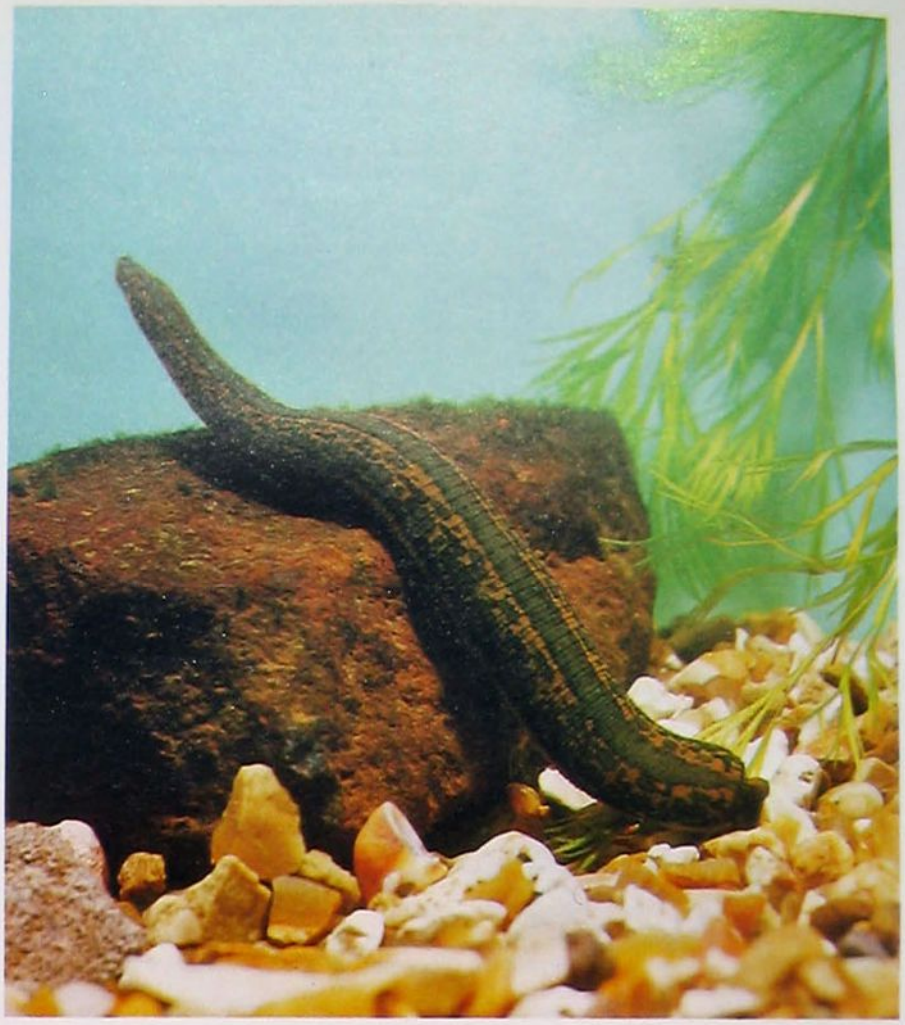
Not all leeches are blood-suckers – many are predators, feeding on invertebrates such as snails and worms. Although parasitic leeches live on the blood of larger animals, only the medicinal leech attacks man.

Leeches belong to the same group of animals as earthworms and, like them, have a segmented body with a thin, flexible outer skin. They differ, however, in the ways that they are adapted to their predatory and parasitic ways of life.

Earthworms continue adding segments to their bodies throughout their lives, while leeches have a constant number of segments (33), which are often difficult to see, being obscured by the large number of 'annuli' or rings on the outer surface of the animal. The shorter body tends to make the leech more agile, allowing it to swim or move rapidly to its host or prey, often with the aid of its suckers.

Light-sensitive leeches To locate prey, leeches have highly developed sensory organs. Some have as many as three pairs of eyes; others, such as *Theromyzon tessulatum*, a parasite of water birds, may be phototactic (in other words, they can sense light). When hungry, this species moves towards the light, changing its body colour as it does so, so that it matches its surroundings on reaching the surface, where it waits for its host. Other species respond to changes in temperature, such as the passing of a warm-blooded mammal, or to vibrations. The fish leech, for example, responds to any disturbance in the water by swimming towards it.

Clinging on A leech has two quite obvious suckers, used for feeding, locomotion and attaching itself to its host or to the substrate. The anterior sucker around the mouth is usually smaller than the posterior one, but size really depends on the mode of life of the leech. Fish leeches tend to have large, powerful suckers, enabling them to remain attached to their fast-swimming hosts. Carnivorous species such as the worm leech may have suckers that are no more conspicuous than the mouth of an earthworm.



Above: The medicinal leech (*Hirudo medicinalis*) is the largest British leech, measuring up to 12cm ($4\frac{3}{4}$in). Its population suffered in the 19th century, due to the collection of vast numbers for bloodletting, and for its valuable anti-coagulant, hirudin.

Below: A gorged specimen of *Theromyzon tessulatum*. A parasite of water birds, it can cause the death of the young. It enters the nostrils of its host and sucks blood from the nasal cavities.

Parasitic leeches do not feed on one species alone, but their range tends to be restricted to either fish, amphibians or mammals. They are extremely adept at removing considerable quantities of blood from their host without being noticed. To do this, they are equipped with precise cutting equipment, and even an anaesthetic substance which they inject into the wound. Leeches also produce an anti-coagulant which prevents the host's blood from clotting and allows the leech to suck it freely. It is this substance that causes leech wounds to bleed so profusely even after the leech has dropped off.

Carnivorous or predatory species, such as the horse leech, catch their prey and devour it whole, using either strong jaws or, in the case of the worm leech, a muscular pharynx. Leeches are even able to survive by using the materials of their own bodies for energy, and as a result may decrease to a fraction of their original size during long periods when there is no host available.

Left: *Hemiclepsis marginata*. Parasite on fish such as pike, roach, bream, carp. Found in stagnant ponds and slow-flowing rivers.

Right: **Worm leech** (*Erpobdella octoculata*). Carnivore, feeds on insects, worms, snails. Ponds.

Above: *Glossiphonia complanata*. Parasite on snails, worms and insect larvae. Found in swift-flowing streams.

Right: **Horse leech** (*Haemopis sanguisuga*). Carnivore, found around lakes, ponds, streams. Under stones in water in winter.

Above: **Fish leech** (*Piscicola geometra*. Parasite on freshwater fish. Found in fast-flowing waters. Cylindrical body.

Right: *Helobdella stagnalis*. Parasite on worms and insect larvae. Found in freshwater, survives mild pollution. Sometimes transparent.

Looking for leeches There are about 16 species of freshwater leeches in Britain, and a number of marine species are known as parasites of various fishes living around our coasts. The freshwater species occur in lakes, ponds, canals, marshes, streams, rivers and drainage ditches. Away from their hosts, they are usually found under stones or in aquatic vegetation. Their main requirement is a solid substrate so they can hang on with their suckers, and vegetation to protect them from predators such as fish or water birds. Most species prefer slow-flowing or standing water in which they can easily maintain a firm hold.

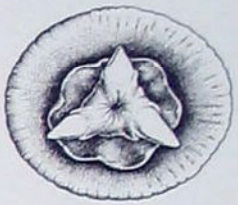
Some species have an ability to survive where oxygen is limited, which means they can live in mildly polluted water. *Glossiphonia complanata* and *Helobdella stagnalis*, both predators, can reach high densities in water with a high organic content, either as a result of natural conditions, or through pollution from sewage or organic fertilisers. This is probably because their main food source–small crustaceans–thrive under the same conditions. However, in heavily polluted water, leeches disappear along with most other forms of life.

Spring breeding Like earthworms, leeches are hermaphrodites, all individuals having both male and female reproductive organs. The breeding season is probably triggered by the temperature of the water, and for freshwater leeches it is usually spring or early summer. Some of the segments near the middle of the body become modified to form a saddle-like clitellum which secretes a cocoon in which the eggs develop. Species such as the medicinal leech leave the water to deposit their cocoons in damp places a little above the water-line. Others, such as the fish leech, cement them to stones under water, while *Glossiphonia complanata* holds the cocoon under its body until the young hatch.

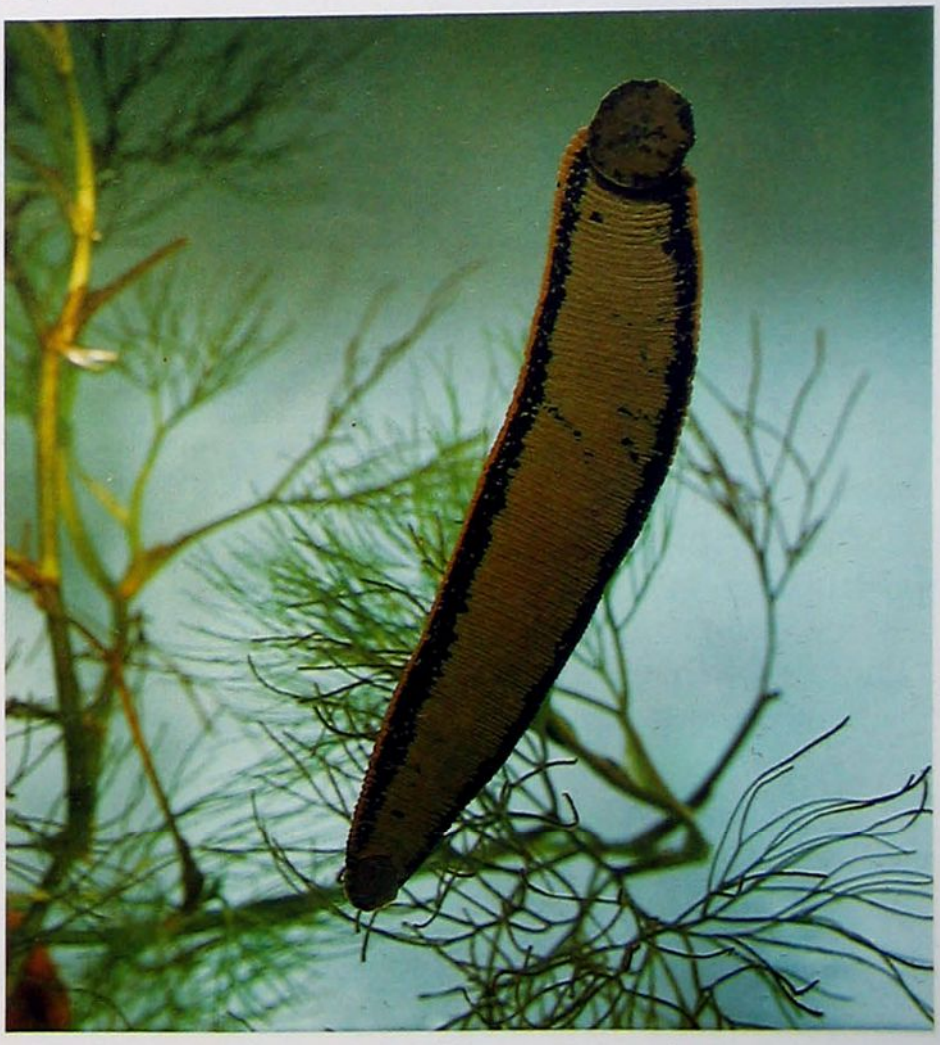
Species of leeches The medicinal leech is probably the most well-known British freshwater leech, but other species are quite common. The mis-named horse leech does not live on horses, but feeds on worms, snails, insects, tadpoles and small fish. It is common on the shores of lakes or ponds where it seeks its prey, particularly at night. The name 'horse' is used simply in the sense of 'large'.

One leech, the fish leech, is a serious pest in fishponds where it is a parasite on trout, salmon, charr, bream, perch, pike and sticklebacks. It is unusual among leeches in preferring fast-flowing streams with a high oxygen content.

Very little is known about marine leeches since specimens are difficult to obtain. *Placobdella muricata* is a species which feeds off the blood of rays, skates, and other cartilaginous fish and it may carry parasites from fish to fish. While waiting for its prey, it rests in a coiled position on the sea bed, attached by its posterior sucker.



Above: The teeth and jaws of the medicinal leech are contained in one of the suckers (below). Through the Y-shaped incision it makes in its host, the leech can pump out up to 5 times its own weight of blood in a single meal. This can support it for a whole year.



NETTLES: PLANTS WITH A STING

Clumps of stinging nettles frequently grow in gardens and on wasteland, and most people will have had an unpleasant brush with them at some time. Yet despite their vicious aspect, they are important weeds – nitrogen-rich and good for the soil.

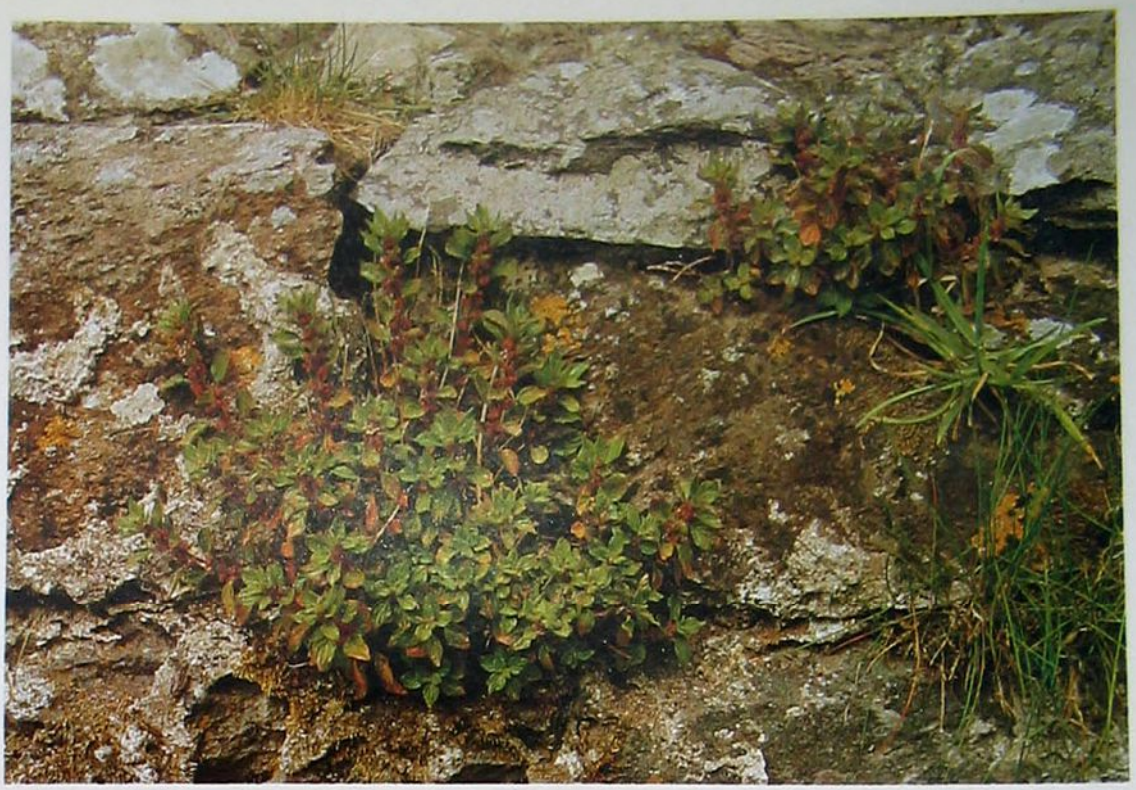
Above: Nettles usually grow on wasteland, in derelict places and in gardens, where they are valuable weeds. When they are cut down and left to decompose, their high nitrogen content returns to the soil, enriching it.

Clumps of nettles are a common sight throughout the countryside, in hedges and ditches, in woods or near buildings. They have a particular liking for rubble-strewn ground and, to grow well, they need a nitrogen-rich soil. As a result, nettles are often found in farmyards and on waste ground such as building sites.

They are vigorous, invasive plants and given ideal conditions the tough, yellow roots branch repeatedly and spread through the surrounding soil. The lower parts of the stems, too, may sprawl and produce roots along their length, helping to establish the plants rapidly over a wide area. Numerous tiny seeds are produced to colonise more distant habitats. Where conditions for growth are suitable, the plants are lush and may reach 150cm (5ft) in height. In poorer conditions, the plants are considerably smaller.

Similar species There are two species of nettle in Britain, the stinging or common nettle (*Urtica dioica*), and the small nettle (*Urtica urens*). They are very similar in appearance, but the small nettle is an annual and, as the name suggests, it is smaller than the perennial stinging nettle, reaching no more than 30cm (12in). Both species have heart-shaped, strongly-toothed leaves which are usually a dark, dusty green.

The small flowers are also green and appear from May to September, forming long, slender, inconspicuous clusters which hang



The red-stemmed wall pellitory (*Parietaria diffusa*), seen here with lichens and other plants in one of its favoured habitats, an old stone wall, is a relative of the nettle. It is widespread, particularly in the south and west of England, and also grows on rocks, cliffs and in hedgerows. Although the plant flowers, it produces green and rather inconspicuous blooms, like the stinging nettle. Wall pellitory had a variety of uses in herbal treatments, from treating coughs to soothing burns. It was also believed to be effective in breaking up kidney stones, a remedy rather dubiously based on its habit of growing from crevices, where it looked as though it was breaking up the stone on which it was growing.

down from the base of each leaf stalk. The male and female flowers of the stinging nettle are borne on separate plants, while those of the small nettle appear on the same plant. The nettle does not rely on insects to pollinate it; instead, pollen is dispersed by the stamens of the male flowers. These remain bent over until maturity, when they suddenly straighten out and flick pollen into the air and onto nearby female flowers.

Barbed leaves Nettles are probably best known for their dense covering of stinging hairs, although individual plants may be completely devoid of these weapons. Each hair is a single, flask-shaped, hollow cell filled with an irritant fluid. The tip of this cell is glass-like due to the presence of silica or lime compounds and is so brittle that it breaks at a touch. The jagged edges of the broken tip puncture the skin and pressure on the softer base of the hair forces the fluid directly into the wound, in the manner of a hypodermic needle.

Different species of nettles produce different toxins. British species produce formic acid and histamine, and the rash caused by the stings, with its accompanying itching or burning sensation, can last for an hour or so, and in extreme cases for up to a day.

Stings and remedies Not surprisingly, most of the folklore of nettles concerns their power to sting and the cure for this. Roman soldiers were reported to have scourged themselves with nettles in order to combat the cold, wet conditions which they encountered in Britain. The tingling and burning sensation from the stings, and the resulting increased blood flow to the surface of the skin, drove away numbness. Belief in this remedy persisted for hundreds of years and urtication, or thrashing the limbs with nettles, became an accepted treatment for arthritis and rheumatism.

Above: Close-up of the brittle, glass-like tips of the hairs on a stinging nettle. These snap off when touched, releasing an irritant, formic acid, which often causes a raised rash on the skin and a stinging sensation.

There are a number of cures for nettle stings but many people still use the traditional remedy of a freshly picked dock leaf wrapped around the afflicted area. This well-known treatment is certainly one of the most convenient, since docks and nettles are often found growing alongside each other.

Docks are not the only plants to bring relief; rosemary, mint and sage are said to be equally efficacious. Oddly enough, the juice of the nettle itself is also supposed to counteract the stings.

Immune insects Flies were believed to have an aversion to the plant and so bunches of nettles were sometimes hung in the larder to keep them away. However, if flies are repelled by nettles, other insects most certainly are not. In summer, nettles attract large numbers of colourful butterflies. They are lured, not by the inconspicuous wind-pollinated flowers, but by the leaves which are food for their larvae. The caterpillars of the red admiral, peacock and small tortoiseshell butterflies

Spotting the difference

Before the white dead-nettle flowers it can easily be mistaken for the stinging nettle, as the leaves are almost identical, lacking only the stinging hairs. The rings of white flowers, however, are very different in structure from those of the stinging nettle, and are pollinated by bees, unlike stinging nettles pollinated by wind.

Stinging nettle

White dead nettle

feed exclusively on nettle leaves. The caterpillars of the painted lady and comma butterflies can feed on other plants, but nettles are one of their preferred food sources.

Family relatives Two other members of the nettle family grow wild in Britain. Wall pellitory is a native plant that, as its name suggests, is often found growing on walls or rocks. It has reddish stems and untoothed leaves and bears only a passing resemblance to the nettles.

Mind-your-own-business was introduced to this country from the islands of the western Mediterranean as a garden plant and now grows wild on banks and walls in south-west England and south-west Ireland. At first glance, it is difficult to imagine that this plant is a relative of the coarse, erect nettle. Its slender, creeping stems and tiny, rounded leaves form dense mats of delicate, bright, evergreen foliage. Neither this plant nor wall pellitory is armed with the stinging hairs of its relatives.

Several plants are frequently mistaken for nettles even though they are not related in any way. These are the so-called 'dead-nettles' which are, in fact, members of the mint family, *Labiatae*. They are strikingly similar to true nettles until their large white or purple flowers appear. However, they completely lack stinging hairs, hence the general names of 'dead' or 'blind' nettles.

Useful nettles

Nettles and their products have been put to many and varied uses in the past, some of which have now fallen out of fashion. The leaves and seeds were widely used in homeopathy and are still sold in herbalist's shops today. They were mainly used as infusions in the treatment of asthma, consumption and other conditions. During the last war, nettles provided essential chlorophyll for the drug industry.

They were also used in drinks, such as nettle tea or nettle beer, which was similar to ginger beer and drunk to relieve rheumatic pains.

Nettles are still used as food for men and animals. The young tops can be boiled, making the stinging hairs flaccid and harmless, and eaten like spinach. Mixed with leeks and rice, they make nettle pudding. The whole plant is eaten in hay by cattle, as the wilted nettles do not sting; the seeds fatten poultry and boiled nettles can be fed to pigs.

When treated like hemp or flax, nettle stems yield good fibre used mainly for coarse sailcloth. This use dates back to prehistoric times—Bronze Age bones have been found wrapped in nettle cloth. Up to the last century tablecloths, bed linen and a fine velvet-like material were also regularly made from nettles.

Top: This woodland ride, fringed with stinging nettles, is an ideal habitat for the nettles and the insects that live on them.

The small tortoiseshell butterfly caterpillars (right) feed on nettle leaves and, along with the egg-laying butterflies, seem to be unaffected by the vicious stinging hairs.

WATCHING WILDFOWL AT SLIMBRIDGE

The 100-acre grounds of the Wildfowl Trust at Slimbridge in Gloucestershire contain the world's largest and most varied collection of captive wildfowl. Every year a spectacular migrant population visits the refuge, too.

A wintery Swan Lake at Slimbridge, where wildfowl of various species have gathered for food. Here you can see Bewick's swans, pintails, and red-breasted, greylag and Canada geese.

The wildfowl refuge is the winter home of thousands of wild swans, geese and ducks, which come here to find sanctuary and food. These birds provide a magnificent spectacle, whether feeding quietly on the fields, flying to and fro in vast, clamouring flocks or coming on to the enclosed ponds among the tame ducks. A nature trail along screened paths and hides gives visitors excellent views of the wild birds without disturbing them.

The entrance into the Wildfowl Trust at Slimbridge is via a large foyer with floor-to-ceiling windows looking out on to the enclosures, which are full of tame birds. The normal route – through an exhibition hall, and then round the grounds, is to the left, but to reach the nature trail, leave instead by the door on your right. This path takes you past the end of a long lawn, towards the Rushy Pen. Turn right through a small gate and along the side of a pool.

Just before you go through the next gate, have a look at two ancient willows standing sentinel on either side. They are mere hollow shells; only the ivy clambering over them seems to hold them up. The cracks and crannies of their interiors provide nesting and roosting places for wrens, robins and blackbirds.

Above: This spectacular sight is of barnacle geese landing in the Big Pen at sunset. Most of the world's species of geese are usually represented at different times. Many are full winged and fly freely around the grounds at Slimbridge. The nearby Tundra Pen has been landscaped to suit such species as Ross's goose, tule whitefoot and the Pacific eider, which breed on the arctic tundras. You should certainly also see Andean flamingos, the first colony in the world to breed in captivity.

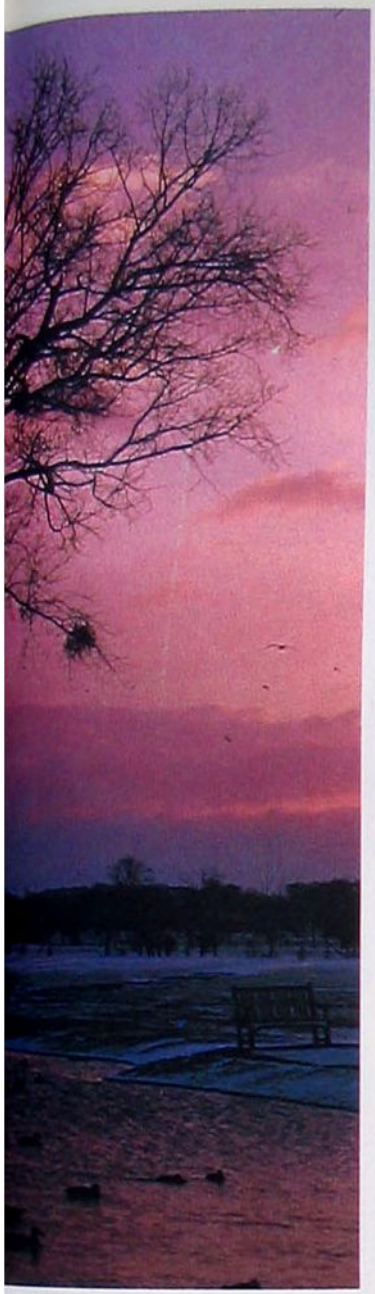
Rushy Pen The path takes you through the gate, across a farm lane and through another gate. Just in front of you is a low hide overlooking the Rushy Pen (**1**). The view here is over the largest of the enclosures, an area of pools, lawns and low shrubs. The pool on the right, with Sir Peter Scott's house beyond, is known as Swan Lake, since over the last 15 years it has become the wintering place for a flock of wild Bewick's swans, which fly all the way from their breeding grounds in arctic Siberia. Four hundred or more come in midwinter, not only for the sanctuary of the refuge but also for the liberal quantities of food that are put out for them.

There are also some tame wildfowl in this enclosure. But the great majority of the ducks you can see – mallard, pintail, shoveler, tufted duck and pochard – are wild visitors, also attracted by the grain scattered into the ponds. Feeding time is usually first thing in the morning, again at about midday and in the late afternoon – about 4pm in February. If you are there at feeding time, you will see the flocks of swans and ducks gathering to meet the keeper who brings the barrow of grain, and then following him round the path at the water's edge until he feeds them.

Inside all the hides there are excellent display boards to help you identify the birds. They explain the birds' backgrounds and feeding habits and outline how the Trust manages the refuge.

Crossing the rhine Leaving the hide, follow the path on your right. As you go, notice the posts holding up the fence on the left. They are only pieces of willow stuck into the ground, but almost all of them have rooted and sent out branches. This prolific tree can be cut time and again to provide poles and stakes; and each one used is a potential new tree.

The path bends (**2**) where it goes over a drainage ditch – called locally a rhine (pronounced 'reen') – and here it is worth looking for water voles. These 20cm (8in) long rodents are quite common round the enclosures. They can sometimes be seen sitting on their haunches holding bits of plant stem or grain in their forepaws while they chew away,



Below: The lesser white-fronted goose. Wintering flocks can be seen at Slimbridge in their thousands. The time to come and watch them is from November to March.

rather like a squirrel.

Growing by the water at this point are a few clumps of rushes. Look for their 60cm (2ft) long thin cylindrical leaves and, perhaps, the brown clusters of seed heads still remaining. The seeds are a favourite food of many ducks, so the rushes have been deliberately planted round some pools on the refuge. You will see more of these from one of the hides further along the nature trail.

Martin Smith Hide Across the rhine, another hide lies in front of you–the Martin Smith Hide (**3**). This is long and narrow with seats arranged in front of slit-shaped windows. Here you have your first view of the refuge, an extensive area of grass, usually with shallow pools of water scattered over it. Just what birds you will see depends very much on the weather, both on the day you are there and in the preceding weeks. If it has been mild, there may be fewer birds to see than if the weather has been colder.

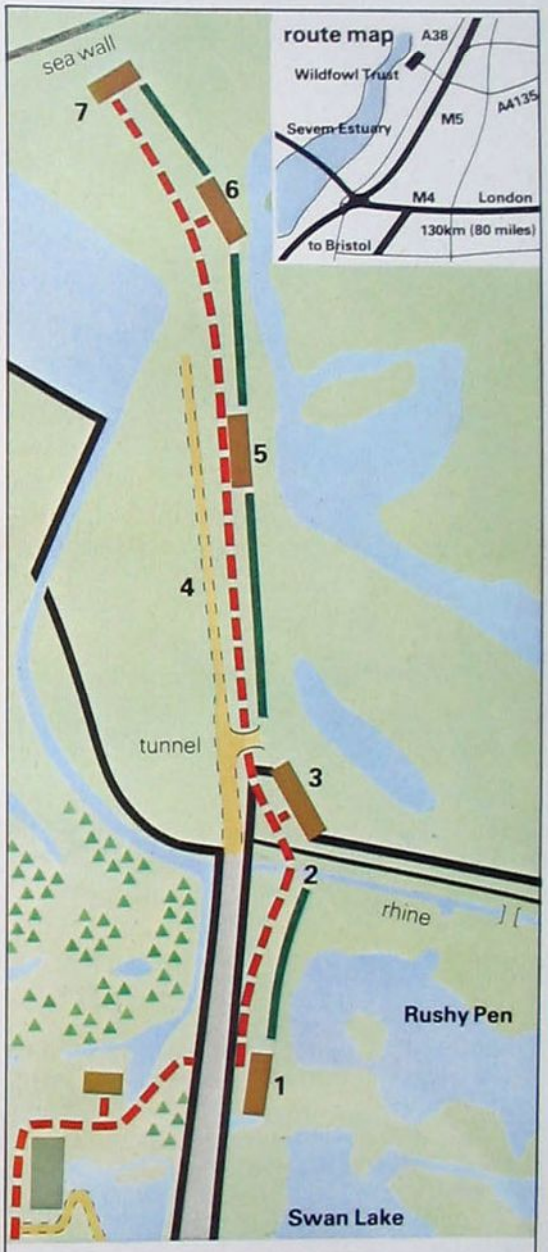
First look for the wild geese. White-fronted geese, which breed in arctic Russia, have been coming to winter at Slimbridge for several hundred years and this is the largest flock in the country. The field you are looking at is one of their favourites on the refuge, though they can range for up to a mile in either direction. The shallow floodwater on the field attracts many ducks, as well as waders like the curlew and dunlin, and several species of gulls.

The nature trail now moves on along the screened corridor (**4**), with a wall on the left and on the right an earth bank, which is topped by a straggling hawthorn hedge. This would be red with berries in the autumn, and fieldfares and redwings may well be feeding on any remaining berries and fruits. In the bank are the holes of rabbits and bank voles, probably too shy to appear during the daytime, but much in evidence when all is quiet.

Halfway Hide The next hide (**5**), after about 90m (100yd), looks out over shallow pools. Look for clumps of rushes planted around the edges. It is not only the food which attracts birds to the pools: they also use the water as a bird bath, especially the geese. If you are lucky, you may see them walk down to the water, drink a little and perhaps have a good all-over wash, with much splashing and flapping. This very necessary part of their body care is always followed by a prolonged bout of preening, to get their feathers into neat order again.

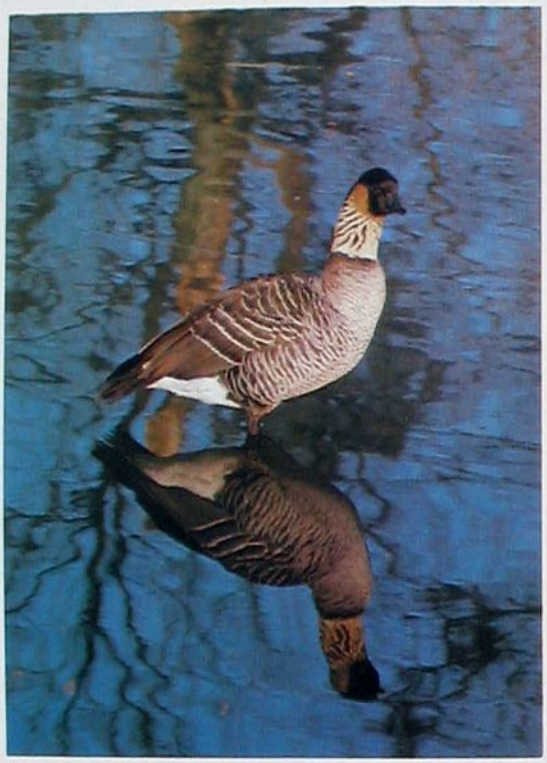
The path takes a slight bend at this point, then runs past another low hide–the Stephen Kirk Hide (**6**)–to the foot of the tower. This hide offers a view over some more small pools.

Holden Tower The height of the Holden Tower (**7**) enables you to look right out over the western half of the refuge to the estuary of the river Severn, here about threequarters of a mile wide. On the top floor of the tower are two very large pairs of binoculars mounted on



Slimbridge is open every day of the year except December 24 and 25. Daily bus services from Bristol and Gloucester stop two miles from the Trust on the A38. There is also a direct daily service from Dursley.

- nature trail
- perimeter
- fence
- farm track
- hedge
- car track
- sea wall
- water
- grassland
- woodland



Above: There is always a wide variety of ducks to watch, as you can see from just this small area of water. In the pond are eiders, red-breasted mergansers, goldeneyes, scaups and red-crested pochards.

Left: One of the functions of the refuge is to raise in captivity those species threatened with extinction – such as the Ne-Ne, or Hawaiian goose. Less than 50 individuals were left when in 1951 three were brought to Slimbridge. From this stock thousands have been reared, and released to re-establish themselves.

Below: Bewick's swans migrate each winter from Siberia. Amazingly every swan is recognised by its bill pattern and known by name to the research workers.

stands to give you a better view. In front of the tower is an area of saltmarsh, flooded at the highest tides. A low grassy bank forms a sea wall to protect the inland fields.

Here is the core of the refuge. The muddy sandbanks beyond the saltmarsh are the night-time roosting place for the majority of the wild swans, geese and ducks. The saltmarsh is the favoured feeding area for many of the geese, particularly early in the winter, and also for a flock of several thousand wigeon, the only species of duck that habitually grazes on short grass. A peregrine falcon always spends the winter on the refuge, preying on ducks and gulls. You might catch sight of it perched motionless on one of the pieces of driftwood scattered over the saltmarsh or, possibly, power-diving through the sky after its selected prey. The peregrine, which was until recent years threatened with extinction, is allowed its place in the refuge as an interesting species in its own right. At the same time, its role as a predator is an entirely natural one in the local community of wildlife.

The centre There is an entrance charge to the Wildfowl Trust grounds. This includes the whole area of the enclosures as well as the nature trail – and you are very welcome to walk round the grounds before or after taking the nature trail. Although the paths are either tarmac or gravel, they can become quite muddy in winter and wellingtons are definitely recommended. You should certainly bring binoculars as well, if you have them. If not, you can hire them at the entrance to the centre.

A walk along the nature trail is rewarding at all seasons, but especially so between about mid-October and mid-March, when the wild birds are present in the largest numbers.

Other centres The Wildfowl Trust has six further centres in Britain. At Arundel, in Sussex, there are 55 acres of landscaped lakes and pens, containing more than 1000 free-flying species. The Trust owns 780 acres of the Washes near Welney in Norfolk and leases a further 70 acres. The entirely wild refuge overlooking the Ouse contains an observatory.

There are 363 acres of marsh and meadow, including a 20-acre man-made lake, at the centre at Martin Mere in Lancashire. From the seven hides you can see more than 100 species of waterfowl from all over the world. At Peakirk in Cambridgeshire the centre includes woodland as well as lakes, while at Caerlaverock near Dumfries in Scotland there are 600 acres of tidal marshland and 235 acres of arable and grass fields. You may hear the natterjack toad singing here in the evenings from mid-April to August. Among the 110 acres of pools and ponds at Washington on the north bank of the River Wear, west of Sunderland, is Hawthorn Wood, with a special nature trail.

PLANTS THAT EAT ANIMALS

Insectivorous plants sound as if they should be exotic and tropical, yet some species are quite common in Britain in areas where there are wet peatland bogs. Their fascinating insect-trapping mechanisms ensure that they obtain nutrients unavailable from the soil in their habitats.

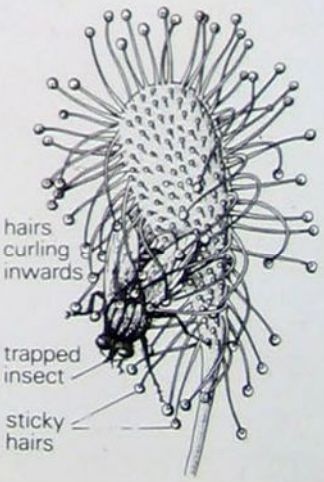
Above: The brilliant colour of this moorland pool is created by the sticky red hairs on the leaves of a carpet of sundews. Nutrients vital to the plants are obtained from animal tissue, in the form of insects. Each sundew plant plant can catch as many as 2000 insects, in one summer alone.

There are three main species of insectivorous plant growing in the British Isles. They all obtain essential nutrients, and amino acids and proteins, by the same method – trapping, digesting and absorbing small creatures (usually insects) – although they differ in their trapping mechanisms. Some of the essential nitrogen for this growth is supplied in this way, and so insectivorous plants are able to grow in areas where conditions would otherwise have been unsuitable.

Bog moss plants Sphagnum bogs, in particular, are often colonized by insectivorous plants. The round-leaved sundew grows in the tussocks of bog moss, while the smaller intermediate sundew is found on bare peat or in the drainage channels leading from raised sphagnum bogs. Both species are found throughout the British Isles, while the great sundew is more common in Scotland and Ireland. This species differs from the others in having leaves held in an erect rosette, whereas the leaf rosettes of the other two are flat and pressed to the ground. The leaves of all three are paddle-shaped and covered with tiny, glistening, pin-like hairs which shine like dew in the sun, giving the plants their name.

Glands on the tip of every hair and on the leaf surface, produce an abundance of sticky mucilage that looks like nectar; an insect attracted to the leaves is soon trapped in the 'glue'. Its struggles trigger off the movement

Below: Once trapped by a sundew, the prey is soon enclosed by digestive hairs.

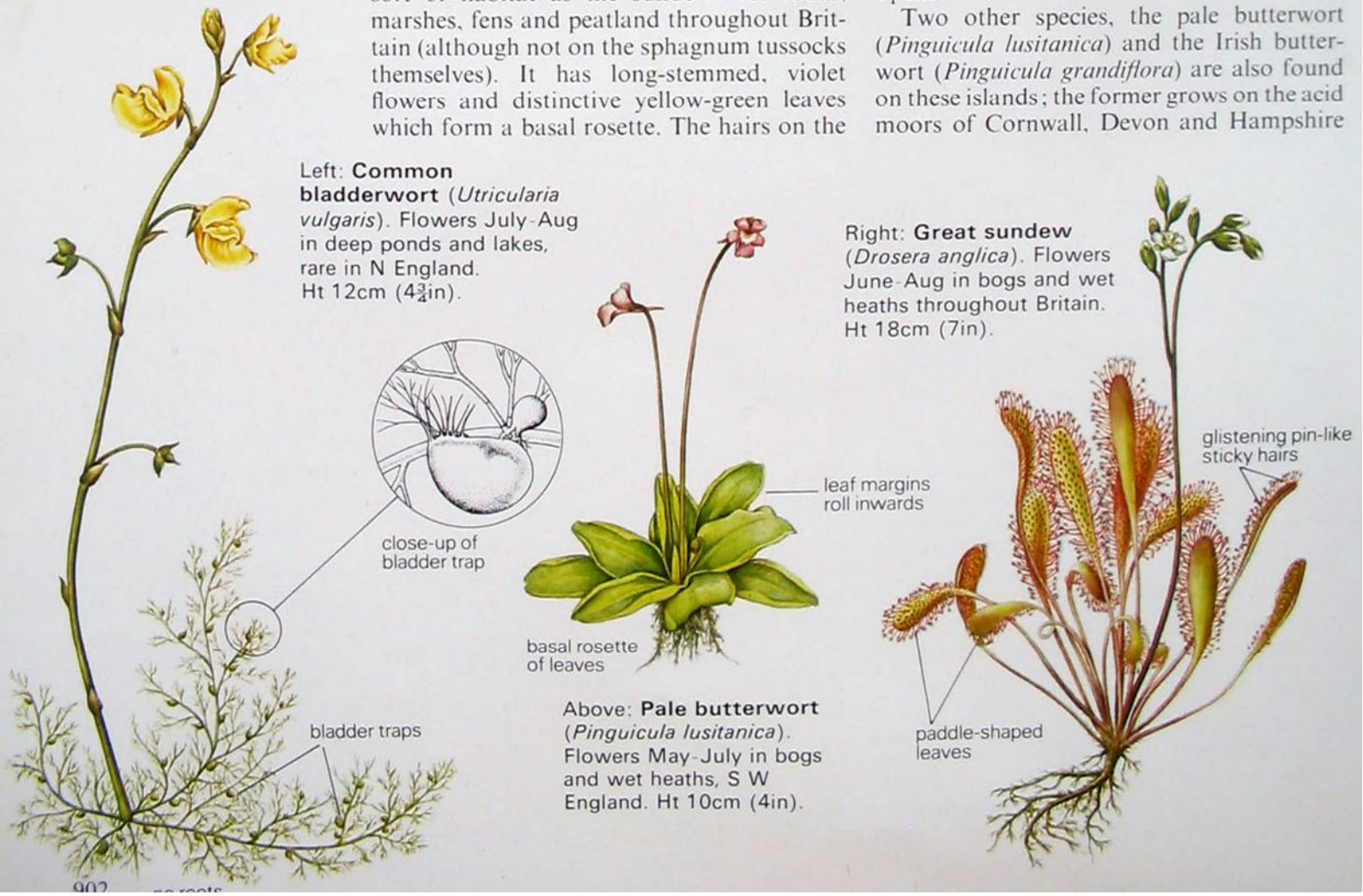


Above: The droplets on the tips of the leaf hairs of the round-leaved sundew (*Drosera rotundifolia*), glisten like dew in the sun. In fact, they are lethal plants and once an insect like this damselfly touches them it is trapped.

of the long, outermost hairs which wrap over the insect. Once it is enclosed by the hairs, digestion by the enzymes present in the mucilage can begin. When the liquefied remains have been absorbed, then the hairs re-open and the fly-trap is ready for action again.

Grasping leaves A similar trap is set by the common butterwort, which favours the same sort of habitat as the sundew – wet rocks, marshes, fens and peatland throughout Britain (although not on the sphagnum tussocks themselves). It has long-stemmed, violet flowers and distinctive yellow-green leaves which form a basal rosette. The hairs on the leaves are microscopic and much more numerous than in the sundews – as many as 25,000 per square centimetre (160,000 per sq in). Any insect landing on the leaf is trapped by the sticky hairs, while the leaf margins roll inwards to enclose it. A thick digestive fluid is produced by the leaf to break down the insect's body so the plant can absorb the nutrients. The process completed, the leaf re-opens.

Two other species, the pale butterwort (*Pinguicula lusitanica*) and the Irish butterwort (*Pinguicula grandiflora*) are also found on these islands; the former grows on the acid moors of Cornwall, Devon and Hampshire



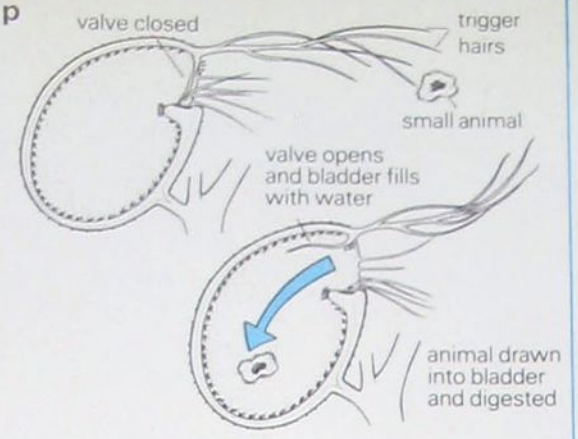
Left: **Common bladderwort** (*Utricularia vulgaris*). Flowers July-Aug in deep ponds and lakes, rare in N England. Ht 12cm (4¾in).

Above: **Pale butterwort** (*Pinguicula lusitanica*). Flowers May-July in bogs and wet heaths, S W England. Ht 10cm (4in).

Right: **Great sundew** (*Drosera anglica*). Flowers June-Aug in bogs and wet heaths throughout Britain. Ht 18cm (7in).

The bladderwort trap

The circular mouth of the bladder trap is closed by a valve, and when a tiny creature brushes by it activates the special trigger hairs that open the valve. The negative pressure inside the trap causes the water to rush in, carrying the animal with it. Here it decomposes, and the remains are absorbed, the waste products being pumped out of the bladder.



and the latter, as its name suggests, in Ireland.

Underwater traps The bladderworts form another small group of native British insectivorous plants, but their lifestyle is totally different from the species already described. They are rootless water plants, and only the common bladderwort is at all abundant, growing in peatland pools throughout Britain. The leaves of the bladderworts are submerged and, like the leaves of many aquatic plants, they are finely dissected to allow easy absorption of food for growth. Some essential mineral salts are lacking in this watery environment, but the plant obtains these essential nutrients from living tissue in the form of micro-organisms caught by its bladder traps. These are tiny, intricate traps, 1-2mm in diameter, which catch rotifers, protozoans and small crustaceans. Male water fleas (*Daphnia*) are quite commonly caught in the traps, which, viewed from the side, bear a resemblance to other *Daphnia*. The males approach the traps with the intention of trying to mate, and are immediately sucked in and absorbed by the plant.

Deadly pitchers Pitcher plants are not native to Britain, although one of them, the purple pitcher plant (*Sarracenia purpurea*), has become extensively naturalised in the sphagnum bogs of central Ireland.

The leaves of the plant are modified to form pitchers, or jug-like structures, which are partly filled with fluid. The pitchers of all these plants are brightly coloured, these particular ones being purple. This colour, along with the sweet scent of the nectar glands at the top of the pitcher, helps to attract insects. They alight on the lip of the pitcher and crawl down into the depths of the water below. Once there, they are prevented from returning to safety by the scaly sides that prevent them obtaining a grip of the pitcher, and by downward-pointing hairs.

The death of the insects is helped along by the powerful narcotics that drip into the water from the nectaries. The bodies are then digested by enzymes produced by special cells in the lining of the pitcher.

Many more carnivores? Insectivorous plants are considered to be a rarity in the plant world. The usual explanation for their existence is that the insectivorous habit evolved from a need to obtain protein, which was lacking in their acid, nitrogen-sparse habitats. In such areas they cannot synthesise sufficient amino acids for their needs. However, one of the founders of modern biology, Charles Darwin, thought that insectivorous habits were much more widespread than acknowledged today. He studied them widely, publishing a book, *Insectivorous Plants*, in 1875. Despite his findings, and those of many other studies since, few botanists acknowledge the evidence that insects are killed and may be digested by many species. Plants such as the tobacco plant (*Nicotiana tabaccum*) and potato plant (*Solanum tuberosum*) are all covered by a variety of hairs, some of which are glandular. These, and other similarly sticky plants, are often seen with dead insects adhering to the hairs. In the potato at least, enzymes capable of digesting insects have been found in the secretions from these glands.

The bright, sticky leaves of the common butterwort, also known as the bog violet, clasp any insect that lands on them. They enfold it and start to digest it, very often while it is still living.

KING OF THE BIRDS

For the birdwatcher there is no more magnificent sight than that of a golden eagle soaring in the sky, yet centuries of ignorance and persecution have brought this bird close to extinction.

Golden eagles were once widely distributed throughout the mountainous regions of the British Isles, but over many years their numbers have steadily dwindled. Now they are essentially birds of the Scottish highlands and islands, with a few pairs nesting in the uplands of south-west Scotland and two pairs recently re-established in the Lake District.

The most reliable estimates put the size of our golden eagle population at 250 to 300 pairs. Their numbers were thought to be fairly stable, but recent evidence suggests that they may be declining slightly. Certainly there are suitable tracts of country where eagles are either scarce or absent altogether, and other areas where breeding success is poor. On the other hand, some areas have thriving local populations.

Despite its lack of numbers, the golden eagle is the most widespread large eagle in the world. It is found in all the main mountainous areas of Europe, from arctic Norway and Russia down to Spain. It has outposts in North Africa and occurs right across Asia, apart from the Indian sub-continent and south-east Asia. It is also found in the New World from Canada down to Mexico.

In all these areas it is primarily a mountain eagle or a bird of wide desolate upland plains, but in some areas it also occurs on rocky sea-cliffs, particularly in north-west Scotland and the Hebrides.

Golden nape Adult golden eagles are mostly brown, although there is a lot of variation between individuals, some birds looking quite dark while others are much paler. All adults have the rear crown and nape a pale straw-yellow – hence its English name. This feature may be difficult to see in the field, but on some birds it can be conspicuous and, in bright sunlight, may appear almost white. Another feature possessed by most adults is paler feathering on the shoulders and wing coverts (where the wing joins the body).

An immature eagle is usually much darker than an adult and has characteristic white patches on its wings. The tail is white with a black band at the end. These white markings disappear as the bird matures, and have virtually gone by the time it reaches the age of five, although breeding adults show traces of it for some time.

Look-alikes In this country the bird most likely to be confused with a golden eagle is the common buzzard. If the bird is not too far away then you can tell the two species apart by size: the golden eagle is much bigger. Otherwise, compare the underparts. Those of the buzzard have characteristic white and dark markings, whereas an adult golden eagle is plain brown and the young brown with white patches.

In poor light or from far away, shape is an important aid to identification. The golden eagle has a long, bulging body and broad wings with fingered tips. The buzzard has a more slender body and narrower wings with rounded tips, and a prominent head and tail. When soaring it holds its wings flatter – buzzards hold their wings up to form a 'V' shape.

Hunting techniques Golden eagles are superb fliers, able to hunt in the wildest terrain and in all but the most ferocious of weather. They rarely rely on sheer speed or manoeuvrability when hunting. For these birds it is a much more painstaking business. The eagle flies low over the ground, patiently going back and forth, contouring along hill sides and across valleys, until it locates its prey, then killing with a swift pounce or a brief chase. The kill is achieved by means of its powerful feet and huge curved talons. The bill may be used to kill prey but is really designed for feeding with afterwards.

Quite often, a golden eagle hunts from a vantage point on a rock or some other look-out in the manner of many other birds of prey. It may even chase down and kill a flying bird, but this is rare. Without some height advantage to give it impetus a golden eagle is not at its best and a fit grouse can usually outfly it over a short distance.

Take-away food Eagles much prefer to carry their food away rather than eat it at the scene of the kill. This limits the size of the prey they attack. Golden eagles are immensely powerful birds, but there is still a lot of nonsense talked about their lifting powers. Much depends on the lift they can get from

Above: The only species likely to be confused with the golden eagle is the buzzard. Close up, size alone separates the two birds, the golden eagle being half as big again. Further away, look for the contrasting light and dark markings on the underside of the buzzard. A mature golden eagle is plain brown beneath, whereas the immature bird has white markings on the wing and tail.

Opposite: A young golden eagle. Older birds develop the characteristic straw-yellow plumage on the nape. Notice the heavily feathered legs and powerful talons for killing.

Golden eagle (*Aquila chrysaetos*). Resident bird of prey, now confined mostly to the Scottish highlands and islands. The male is 75-90cm (30-35in) long; the female usually

Above: Golden eagles feed off a variety of prey, the most common being rabbits, hares, red grouse and capercaillie. Near the coast, seabirds are an important source of food. They also eat carrion to a much greater degree than is usually realised.

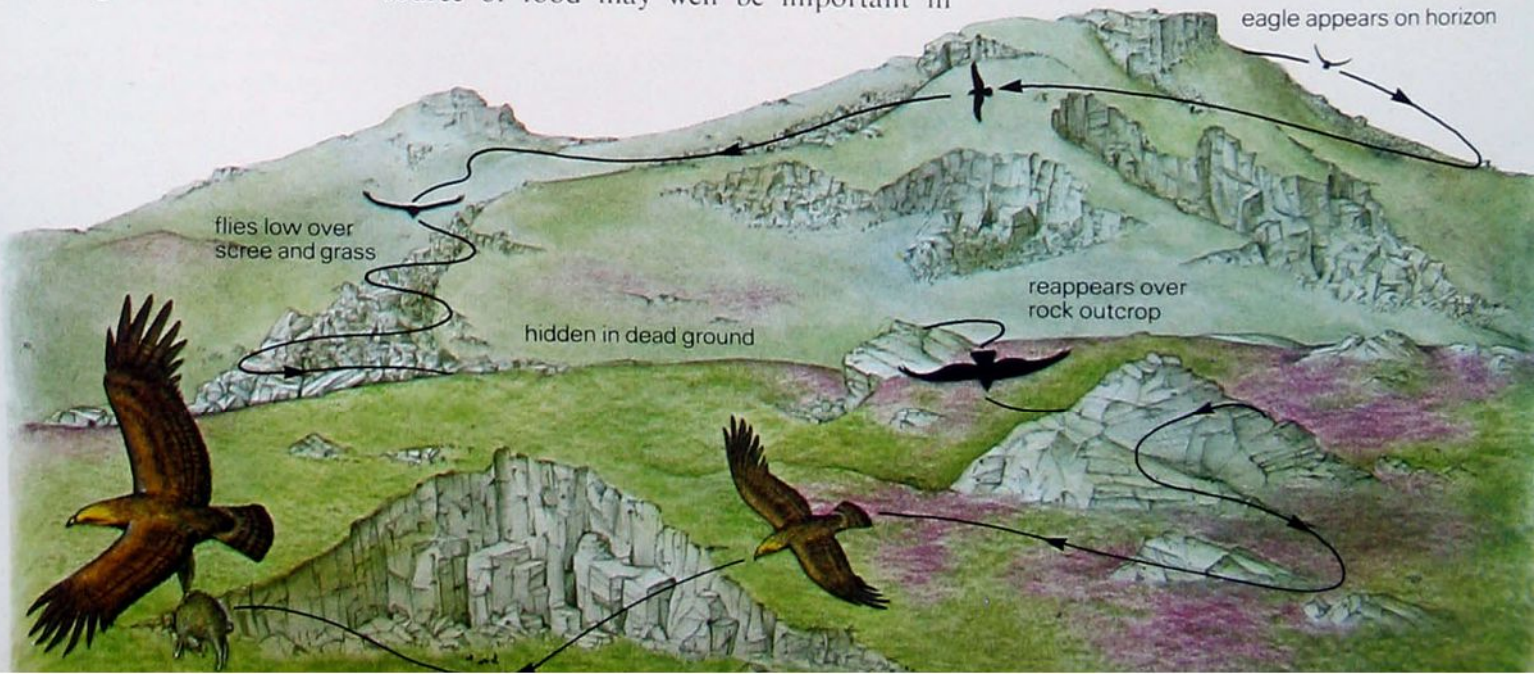
Below: When hunting, a golden eagle flies low over the ground, following the contours of hillsides along valleys and skirting hill tops in the hope of catching prey off guard.

they can take off downhill. Normally, however, under the most favourable circumstances they can lift only as much as their own weight – a large hare, say.

Nevertheless this still leaves the golden eagle with a wide choice of prey. Scottish birds can kill almost any small to medium-sized mammal or bird, from mice and sparrows up to capercaillies and young deer. Some of the more unusual kills include cats, dogs, fox cubs, squirrels and geese. But most of the prey taken consists of just a few species: rabbits and hares, and among birds, red grouse and ptarmigan. Eagles also feed on carrion, mainly sheep and red deer. This source of food may well be important in winter and in areas where prey is scarce.

Pairing and breeding By the time a golde eagle reaches the age of five it is ready to fin a mate and breed. The pair then establishes hunting ground, usually about 20 squar miles in Scotland, though sometimes it ca be as large as 30 square miles. Golden eagle are not territorial about their huntin grounds; adjacent areas often overlap.

Golden eagles pair for life and are largel sedentary, staying within their huntin grounds. Sometimes, however, an immatur eagle may move in to replace a lost partner, o it may occupy a hunting ground singly o with another immature eagle.



In late winter, with the approach of the breeding season, the male performs a courtship display. This consists of a spectacular rising and falling sky-dance and is sometimes performed by the female as well.

Nest-building or repairs begin in March. An established pair usually has several nests and favourite sites: on cliffs or crags – not necessarily high up or inaccessible – or even in trees. Each year the pair either picks one of their nests and repairs it for the coming season, or it establishes a new nest.

The nest itself is built with branches and heather stems and lined with finer vegetation. Two eggs (sometimes one, rarely three) are laid in late March or early April and are incubated for about six weeks, mainly by the female.

The young chicks exhibit a curious phenomenon known as the 'Cain and Abel battle', in which the elder of the two chicks kills the younger one, usually within the first three weeks of life. This battle occurs in 80% of nests in which two eggs are laid. Why this happens and what its function is ornithologists do not yet know, and it is still the subject of much debate.

The young survivor stays in the nest for 10 to 11 weeks before fledging, after which it remains dependent on its parents for many weeks more.

Persecution Despite being protected by law our golden eagle population still faces many threats and its continued survival in this country is by no means assured. Unscrupulous egg-collectors still raid nests, and traditional haunts of the golden eagle are being disturbed by tourism and development. But the most serious threat comes from certain farmers and gamekeepers who believe, wrongly, that the golden eagle conflicts with their interests.

Above: The eggs, usually two, are laid in late March or early April at intervals of three to four days. They are white, usually with brown or red blotches. Incubation is mostly by the female alone and takes about six weeks.

Right: During the first three weeks or so, the older chick is likely to attack and kill the younger one. In only one nest out of five where two eggs hatch do both young survive.

Below: The young golden eagle develops its feathers at around four to seven weeks and begins flying at about 10 to 11 weeks, though it remains dependent for many weeks more.

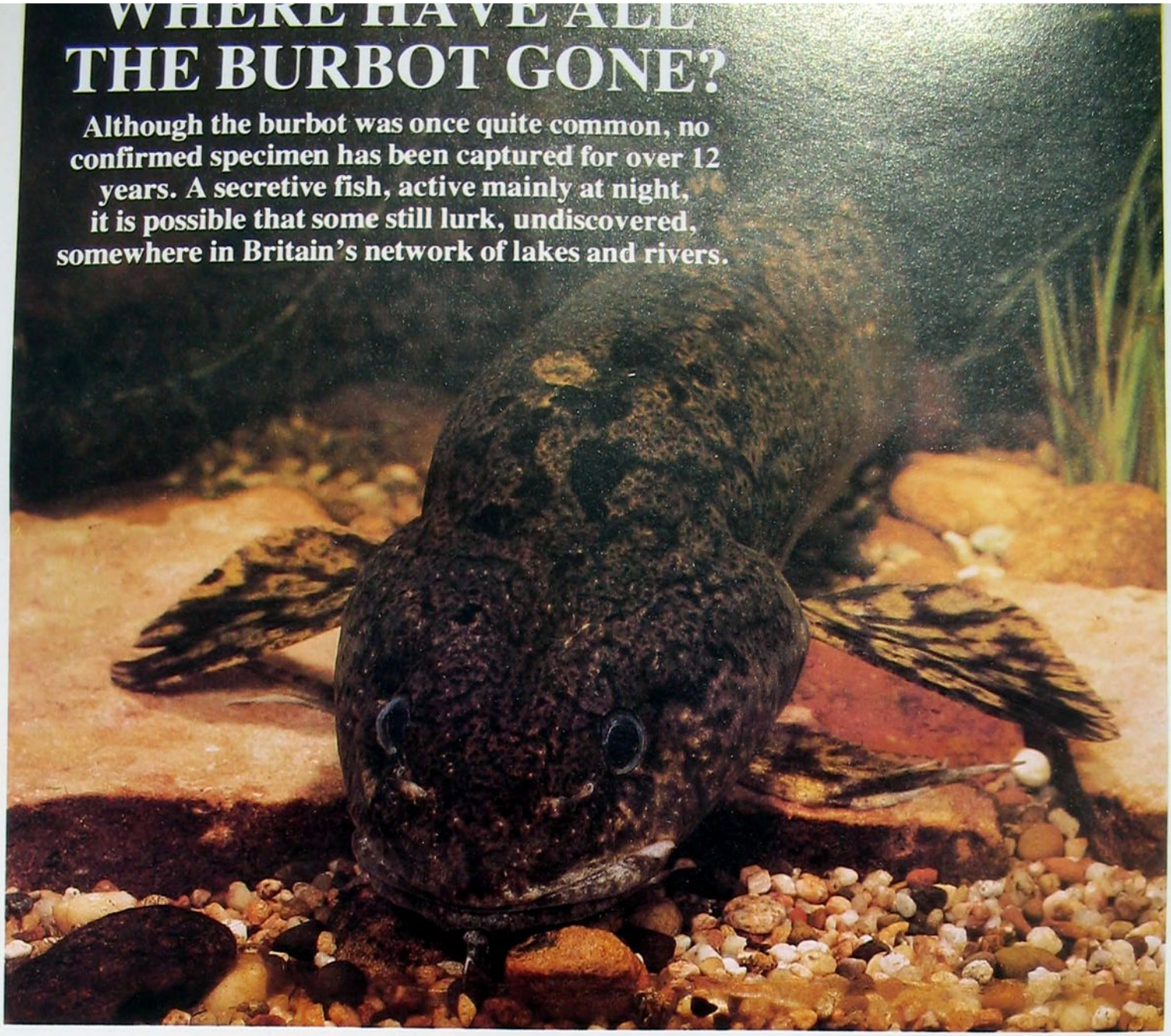
The problem arises because the golden eagle eats grouse and, occasionally, lamb. Grouse is an important part of the eagle's diet, but research shows that it eats only about 220-280g (8-10oz) of food a day. This is too insignificant an amount to affect seriously the quantity of grouse, yet some people are still ignorant enough to think that an eagle kills dozens of grouse a week.

The same sort of misconception occurs with eagles and lambs. Some eagles do kill lambs, but the numbers taken are tiny and never on a scale to do much serious damage, as is sometimes alleged. Most lambs eaten by golden eagles are taken as carrion, and there is never any shortage of dead lambs in the Scottish hills in spring.

Such prejudices mean that golden eagles are still being systematically persecuted by people who do not know the facts. The biggest problem facing conservationists in the highlands of Scotland today, at least where birds of prey are concerned, is trying to persuade people that golden eagles do far less damage than they think.

WHERE HAVE ALL THE BURBOT GONE?

Although the burbot was once quite common, no confirmed specimen has been captured for over 12 years. A secretive fish, active mainly at night, it is possible that some still lurk, undiscovered, somewhere in Britain's network of lakes and rivers.



The burbot is a member of the cod-fish (Gadidae) family which is widely distributed in the temperate seas of the world, although most common in the North Atlantic. Worldwide, there are probably 60 species in the family, and all but one of them are sea fishes. The one exception is the burbot, which lives exclusively in freshwater.

Its geographical distribution is also remarkable, for it is found right across the northern hemisphere. In North America, it ranges from the Atlantic coast across Canada and the United States into Alaska, then from Siberia to Sweden, France and England. Its distribution here was restricted to eastern England, from Yorkshire southwards to Suffolk.

Ancient origins The explanation for this limited distribution is believed to lie in the past history of the British Isles, just after the last Ice Age. Then, what is now the North Sea was spanned by a land bridge over which many animals crossed to colonize our islands. Although described as a land bridge, it must have been as much water as land, but it was fresh water from the rivers of what is now northern Europe such as the Rhine and Elbe, as well as from melting ice. Conditions probably consisted mainly of swamp, with patches of dry, high ground surrounded by an interconnected mass of freshwater channels.

Many of the fishes that make up Britain's fauna moved through these channels to colonize our rivers which, during the period of ice cover, had been denuded of much of their life. Some species were well-adapted to life in fast-flowing water and spread through the eastern river system into other rivers. Other species, such as the burbot, ruffe, silver bream and spined loach, preferred still or slow-flowing water and never spread widely. They tended to be confined to the eastern

Above: When the burbot hunts for food, an activity of the half-light hours of dawn and dusk, it swims slowly over the lake or river bed with its chin barbel thrust out. Much of its hunting is guided by a keen sense of smell; the tubular front nostrils are used to localise the source of odours. The burbot also has a complicated pattern of sense cells in the lateral line extension on the head.

Opposite: The slow-flowing reaches of lowland rivers like this one, the River Brett at Hadleigh in Suffolk, are typical of the places where burbot could once be found.

The burbot (*Lota lota*) has a slender body with a broad head, two dorsal fins (the first short and the second long), and a single anal fin. Its affinity to the cod can be seen in the structure of the tall fin, but most of all in the long chin barbel.

counties of England.

Doomed species Historical records of the burbot show that it was once common in the River Trent and other rivers that flow into the Humber estuary. It was also abundant in the Fens, the Great Ouse, the Broads and as far south as the Suffolk Stour. By the 1880s it became obvious that it was much scarcer than it had been half a century earlier and in *The Fishes of Great Britain and Ireland* Francis Day wrote that 'the species is decreasing in numbers and perhaps doomed to extinction'. Records over the next century have shown that his guarded prediction was all too accurate.

The capture of a burbot by an angler in the Old West River in Cambridgeshire in September 1969 is the last absolutely certain record of the species in Britain. This capture led to a great deal of interest in the species, and one angling newspaper later offered a substantial reward for the capture, verification, and return alive, of a specimen – but has never had to pay out.

Surveys conducted by local water authorities in areas where the burbot used to occur have failed to find any. Although it is difficult to be absolutely certain, it now looks as though the British burbot is extinct.

Isolated populations The reasons for its decline and probable extinction are not easy to pinpoint, because while our burbot have died out, those in Sweden, Germany and North America have shown no sign of diminishing in numbers. Probably an important factor is that our populations were at the extreme western limit of the species' range. Therefore, they were cut off by the North Sea from European populations, and isolated into sub-populations that lacked genetic diversity within each river. Such small sub-populations would be more vulnerable to local problems such as drought or pollution. The Trent, for example, was badly polluted in the 19th and early 20th centuries, although it is fortunately very much cleaner now.

Right: Crayfish provide food for small burbot, along with aquatic insect larvae, molluscs, and other invertebrates. Adult burbot feed on small fishes as well, mainly bottom-living species, and they are also known to eat the eggs of bottom-spawning fish such as salmon and trout.

Below: The distribution of the burbot was limited to eastern England, from the Yorkshire Derwent down to Suffolk.

Burbot lifestyle In Sweden, where the species has been studied, spawning takes place in mid-February, when the lakes are ice-covered and the temperature on the lake bottom is below 4 C (39 F). The burbot spawns over clear sandy or rocky bottoms. (Eggs falling into mud are covered and suffer from lack of oxygen) and the eggs sink to the lake bottom in about 24 hours; 35 days or so pass before they hatch.

Outside the spawning season the burbot spends most of the day hidden under rocks, among roots, and in holes in the river or lake bed. Studies of captive burbot in Scandinavia have shown that they are most active in the half-light – early in the evening and around dawn – when they hunt for food, but the night time hours are occupied with low level activity.

Always a rare fish, the natural history of the native burbot was never closely studied. Its disappearance from our rivers leaves Britain's fauna considerably the poorer and the opportunity to learn more about this secretive and little-known fish is now probably lost for ever.

TOP CATS: GOING BACK TO NATURE

Feral cats–cats whose ancestors were domesticated but are themselves living wild–have existed for generations around towns, farms and the wild places of Britain.

A feral cat is one that was once domesticated, or whose ancestors were domesticated, but which has reverted to the wild state. The cat was one of the last animals to be domesticated, and adapts easily to a wild, free-living existence. However, the feral cat does not live only in towns, for, in addition to the marauding alley cats slinking in the shadows of back streets, generations of feral cats have lived on the fells and other wild places of Britain. As we sailed out on voyages of exploration so our cats travelled too, and many islands throughout the world now also have feral cat populations.

Scottish relatives The domestic cat is closely related to the forest wild cat (*Felis sylvestris*) or, as it has become known in Britain, the Scottish wild cat. This relationship is made even closer by the fact that the two varieties can, and do, interbreed.

Feral populations Areas of suburban housing, with their usually large domestic cat populations, are not conducive to the formation of feral colonies. Therefore in towns, feral cat colonies tend to form in non-housing places such as hospital compounds and factories. Here they may use an area such as a square as a communal meeting place. In the countryside, feral cats do not usually encounter the problems of competition for territories, although they may have to compete with domestic or semi-feral cats at prime sites such as farms and factories. Food is normally scarcer than in towns, and this factor alone helps to regulate feral populations in out-of-town areas.

In Britain a large percentage of the cat population is living in a feral condition, usually by their own endeavours. In towns and cities, and particularly in the huge conurbation of London, there is a far higher population of feral cats than the available food could support, were it not for the vast army of auxiliary feeders–usually elderly ladies–who provide food for many of them.

Social graces Feral cats may, on meeting others of their group, raise tails in greeting, and rub heads and flanks in a very social manner–even though cats normally prefer to

Above: Feral cats living in the countryside–like this one with tabby markings discovered on a moorland track–are usually in surprisingly good condition. Feral animals living in such places must rely normally on their own hunting abilities to catch food and, as with any other wild population of animals, the strongest survive.

Opposite bottom: Feral cats frequently use non-territorial areas like a town square as a communal meeting place–especially if they have become accustomed to finding food there. Here, some of the cats are in poor condition, and it is unlikely they would be able to survive without these handouts.

'keep their distance'. Similarly, during the day when much of their time is spent resting, related cats may sleep side by side. In particular, sub-adults often stay near their mother. As well as reinforcing social group bonds, such contacts also transfer scent, which leads to a group identity.

Most members of the cat family live in forest or woodland, where it is not possible to scan territory visually, and therefore scent marking is important. Toms (males) have a home range approximately ten times greater than the area patrolled by queens (females). Toms mark out their territory with a characteristic strongly smelling spray, but all cats also mark their territory in less obvious ways. They have scent glands under the chin, on the top of the head, along the midline of the back and also along the tail.

The glands that provided the scent during social contact are also used when marking out the territory. Scent is normally transferred to some prominent object so that it serves as a warning to any cats entering the territory. The end of an obstacle such as a low twig or straw projecting into the cat's path is closely investigated by careful sniffing, after which the cat usually rubs the side of its chin against the end of the obstacle, or at least brushes its body against it. In towns, feral cats adopt the same tactics, rubbing themselves against the sides of fences, buildings and other structures. Car hubcaps, too, seem to be favourite sites.

This simple act fulfils a number of functions. The cat is able to determine if it was the last cat to pass that way or, if another cat has passed by, it also enables an 'identikit' to be built up on the cat in question, giving information such as the sex and state of sexual maturity. This explains why a cat will investigate such a 'scent stick' even if it can see the other cat walking on ahead.

Above: Examining a 'scent stick' (left) can tell one cat much about another. Cats often examine these territorial boundary marks, even if the cat which left the scent is visible, for they relay information such as the sexual condition of the cat. Apart from the male's habit of urinating (spraying), scent can also be transmitted from glands on the head, back, tail and under the chin. Queens (females) will often spend several minutes 'chinning' the ground (right).

Right: The image of a cat as a solitary animal is confounded by feral cats, where strong family ties and the establishment of a hierarchy with 'pecking orders' exist.

Hunting The feral cat is an enterprising opportunist. As a member of the cat family it is, among mammals, the supreme solitary hunter, and catching live prey presents no problem. On isolated islands off Scotland where no man is present, generations of feral cats have had to depend on their impressive armoury of keen senses and stiletto-fine teeth and claws to catch prey in order to survive. They prey on nesting seabirds and their young, but nonetheless also readily scavenge carrion. Likewise on the mainland feral cats will as readily devour a road-casualty rabbit as one they have killed themselves. Similarly, the presence of man nearly always means there is a greater variety of scavengable food available – not just for the feral cat but also for other nocturnal opportunists like the fox, hedgehog, rats and mice.

In towns and cities, our waste provides a super-abundance of food, which is largely responsible for the high urban density of the fox as well as the urban feral cat. Changes in

the type of refuse to be found in dustbins – less ash due to a reduction in coal fires meaning less contaminated scraps – and the increase in the use of plastic bags to hold refuse, means that these containers are easy and valuable prey to the deft razor-sharp claws of scavenging cats. Certainly the urban feral cat finds this more profitable in terms of energy expenditure than chasing pigeons in the park. Cats are rather inept at catching adult birds, anyway, never seeming to have understood the sneaky escape route of flight.

Producing offspring In towns, feral cats usually seek quiet, undisturbed places within the home territory in which to have their litters. Some unusual places have been recorded, including overturned dustbins and the back seats of cars. In the countryside, anywhere which offers a suitable den may be chosen, haylofts in old farm outbuildings being a particular favourite.

Due to the lack of veterinary care, ailments such as eye infections and the dreaded cat 'flu are common among feral cats. As a result, kitten mortalities tend to reduce litter size to about four, which is more compatible with food availability than the larger litters reared by domestic cats.

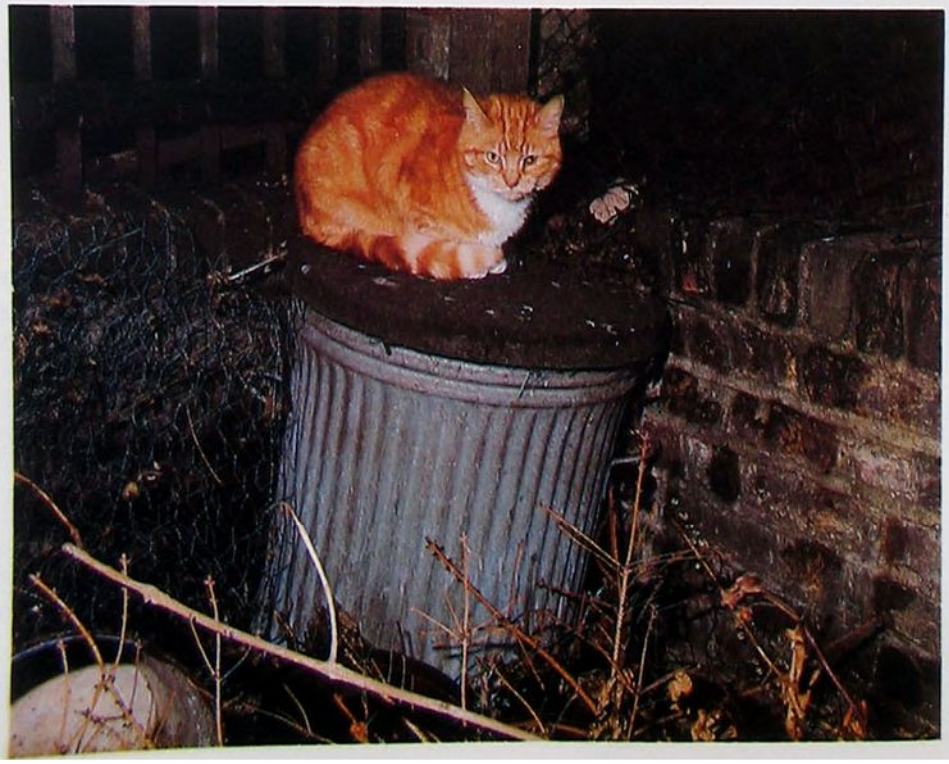
There are examples of feral offspring being successfully reared in a domestic situation, although these kittens usually exhibit more aggressive behaviour and are generally less tractable than the offspring of domestic cats.

The offspring of a feral tom cat and a domestic queen (female) can usually be reared successfully as pets. Domestic cats, unlike all other domesticated animals, are free-roaming once they escape the confines of the house. They have their own home ranges and defended territories like any truly wild animal, and a feral tom can compete for a domestic queen in just the same way as a domestic tom.

Above: Family portrait. Hay lofts provide the ideal place for producing and rearing a litter of kittens. Feral cats may also mate with Scottish wild cats and domestic cats.

Above: Despite the alert, crouched hunting techniques adopted by cats, many attempts end in disaster.

Below: Eye sores, like the one from which this feral cat is suffering, are common.



The feral cat's future

Although in the countryside feral cats have been very successful for centuries with little or no harmful effect on the environment, in certain places they are considered, on health grounds, to have been too successful. Hospitals in particular, with underground networks of ducting, surrounding grounds with shrubs, huge bins of waste and often a soft-hearted nurse offering extra food, have become a popular focal point for many feral cats. The health authorities have for many years tried to enforce a policy of eradication, which in urban areas has failed. More recently, it has been realised that biological control through an understanding of the feral cat's way of life is a more acceptable way of dealing with the problem. Instead of trapping and killing the cats, a proportion of the animals are neutered, medically examined and then returned to the site. The presence of these cats tends to stop others straying into their territories, but means that numbers do not increase.

PARASITIC CARRIERS OF DISEASE

Fleas and lice have always been scourges of mankind, spreading diseases which have killed millions of people. They are parasites, adapted to life on a variety of hosts.

The very words 'lice' and 'fleas' conjure up horrific thoughts of blood-sucking parasites. Yet these insects have an interesting lifestyle of their own, being specially adapted to live at the expense of other creatures. Both lice and fleas are wingless parasites of birds and mammals, but they are not related to each other at all. Fleas have a complete metamorphosis, with both larval and pupal stages, but in lice the metamorphosis is gradual, the young (nymphs) simply looking like small lice.

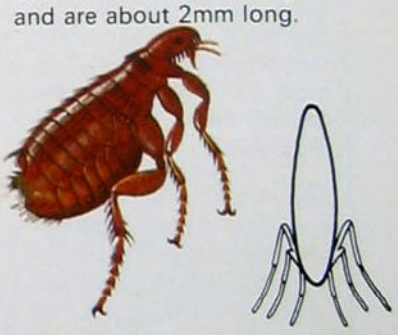
Fleas and lice have been living with man from time immemorial, and it is only recently that we have been able to deal with them so that in the civilized world both are comparatively infrequent. This is important since some can carry rather dangerous diseases.

Unwelcome jumpers Fleas may be fairly familiar to owners of dogs and cats since these animals have their own particular species which sometimes appear in large numbers in houses. Fleas are small, hard, shining brown or blackish insects. They are compressed from side to side to enable them to scramble about among their host's fur or feathers, being assisted in this by backward directed spines that make them very difficult to dislodge. Their hind legs are powerful and enable them to jump well; a distance of 30cm (12in) has been recorded for the human flea. Jumping is mainly used by fleas to reach a host, but also to escape if attacked. Their antennae are short and their mouth appendages beak-like and adapted for blood sucking.

Hitching a ride for life The white eggs of fleas, about ½mm long, are large for the size of the animal. Each female drops several hundred eggs into the host's nest or sleeping place. Here they hatch after about a week into small legless larvae with long sparse hairs. The larvae move with a characteristic jerky motion and feed on organic detritus supplemented, in some species, by particles of dried blood excreted by the adult fleas. After two or three weeks they pupate in loose cocoons, changing to adults in a further two to three weeks.

Above: The rabbit flea (*Spilopsyllus cuniculi*) is the main carrier of myxomatosis, a disease that has killed many rabbits.

Pubic louse (crab): lice are compressed from top to bottom and slow moving, and are about 2mm long.



Cat flea: fleas, 2-3mm long, are compressed from side to side to enable them to scramble among fur.

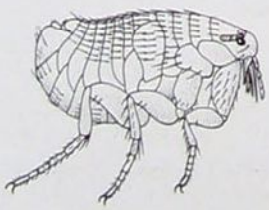
Above: Squirrel flea *Orchopeas howardi* introduced from America with the grey squirrel. Fleas parasitise only those mammals or birds that have a lair or nest. Wandering species of animals, such as ungulates (hoofed mammals) or monkeys, do not have fleas because there is nowhere for larvae to live.

Below: The larva of a bird flea from a house martin's nest. It feeds on organic detritus from the young and adult birds.

The plague flea

Fleas act as transmitting agents for the bacillus that causes bubonic plague. This is really a rodent disease, transmitted by rodent fleas, the stomachs of which become blocked by the multiplication of the bacilli. Death of the host, and hunger through inability to swallow, causes the fleas to search for other hosts and to bite repeatedly, injecting the new host with the bacilli as they do so. In this way the plague can spread rapidly.

The main culprits in plague epidemics are the black rat, now found only in ports in Britain, and the tropical rat flea *Xenopsylla cheopis* (below) which bites man readily. The plague, or black death, of the 14th century probably killed half the population of the Old World; the epidemics in London alone between 1563 and 1665 killed nearly 200,000 people. At that time the black rat may have been more common than it is now, but the identity of the carrier flea has never been discovered.



The adult fleas do not leave their cocoons immediately, but stay inside feeding for up to a year, waiting for the stimulus of vibrations made by a potential host animal. Then all the fleas in a batch emerge at once and endeavour to hop on to the host. This habit accounts for the sudden plague of fleas that can be seen if someone enters an empty house in which dogs or cats had been kept.

Flea hosts Each species of flea – there are 56 in Britain alone – has its own preferred species of host or hosts. Although they may sometimes bite the wrong hosts, they do not seem able to transfer to them and breed successfully. Some are found only on a single host, for example the hedgehog flea (*Archeopsylla erinacei*), while others occur on two or more hosts. The human flea is an example of the latter, also being a parasite of pigs, foxes and badgers.

Adult fleas, once out of their cocoons, live for several months to a year, and can fast for as long as six months. Some, like the rabbit flea which is responsible for transmitting myxomatosis, are sedentary and attach themselves permanently to their host (they are known as 'stick-fast fleas'). Others are more mobile and spend much of their time in the nest or lair, visiting the host frequently to feed.

Blood suckers When a flea bites it thrusts its sharp sucking tube into the host's skin, injecting saliva to prevent blood coagulation, and then pumps blood up into its gullet. The saliva causes reaction and itching, and the bite is characterised by a tiny dark spot in the centre, the bites appearing in groups. Fleas bite and suck up much more blood than they can digest. The excess blood is passed out partially digested, producing the dried particles needed by some larvae, and, in the case of human infestation, marking linen.

Fortunately, careful attention to hygiene and the use of vacuum cleaners make human fleas fairly uncommon nowadays. Most domestic infestations of fleas come from pets, or perhaps from birds' nests in the roof.

The life cycle of lice Lice, unlike fleas, are completely adapted to living on the host (or in clothing in the case of human hosts), both

Above: A pair of pigeon lice (*Columbicola columbae*) clinging to the feather of a dove. Heavy infestations of such lice may result in irritation and even loss of plumage. It is thought that the dust baths some birds take may be efforts to reduce the number of lice in the feathers. Female lice lay their eggs on the birds' feathers, cementing them firmly so they cannot fall off. In this way young birds become infested in the nest. The lice feed on bits of skin and feathers.

Parasitic adaptations

The human flea (*Pulex irritans*) has beak-like mouth appendages adapted for blood sucking (inset), and powerful jumping legs.

The human louse (*Pediculus humanus*) is equipped with a single large claw on each leg (inset). The claws grip hair.

A biting louse has two claws to each foot (inset) for holding on to its host, and chewing mandibles for feeding on hairs.

when young and as adults. They can survive away from the host for only a few hours or, at the most, for a day or so.

Female lice cement their eggs (known as 'nits') firmly to hairs, feathers or clothes. The eggs hatch after four to seven days into nymphs resembling the adults and feeding in a similar manner. After about two to three weeks, and three skin moults, they become adult, living for about one month more. The females of most species lay between 50 and 100 eggs, although the human louse is recorded as laying as many as 300.

Chewing and sucking mouthparts Lice fall into two groups, the bird or chewing lice with chewing mandibles, and the sucking lice with mouth appendages highly modified for piercing and sucking.

Bird lice are essentially parasites of birds, but a few species infest dogs, cats, horses and cattle. Their legs generally end in two claws and they feed on particles of skin and fragments of feathers and hairs, although some species have been seen to take blood from wounds. Sucking lice infest mammals only, and are the more important group as two or three species live on man, one of them a possible carrier of disease. Sucking lice are grey and leathery, 2-4mm long, and each leg terminates in a single large claw for gripping hair.

The human louse *Pediculus humanus* exists in two forms: the *capitis* form on the head and the *corporis* form in the clothing. The crab or pubic louse (*Pthirus pubis*) has larger claws and lives among coarser hairs, particularly in the pubic region.

Body lice are unusual in that they have become adapted to live in clothing, laying their eggs along the seams. They are able to survive away from their host overnight if the clothing is removed (it often isn't in chronically infested people).

It appears that all lice are transferred to fresh hosts by bodily contact, that is by young in a nest or by adults living close together. Human body lice may occasionally be picked up from upholstery, but lice generally are most abundant in conditions where people sleep close together and seldom change their clothes.

Carriers of disease Body lice transmit two diseases of man: typhus and relapsing fever. Typhus is normally spread via the faeces of infected lice, the lice having been transferred from an infected person. Typhus has ravaged armies throughout history, and there are many cases of campaigns failing because of this louse-borne disease. For example, in 1643 King Charles I abandoned his plan of marching on London because of a typhus epidemic in his army (it also affected the Parliamentary troops). Relapsing fever is passed on only when an infected louse is crushed near a small wound or abrasion. It is a much less serious disease.

Above: Human head lice (*Pediculus humanus capitis*) on hair. These are sucking lice which have mouthparts adapted for piercing and sucking blood. Chimpanzees are parasitised by another species. Although anyone can pick up lice, they are unlikely to survive on people who wash and brush and comb their hair often, wash regularly and change their clothes frequently. Laundering, ironing and dry cleaning are death to lice.

THE EVERGREEN HOLM OAK

It is surprising to discover that many of the hundreds of oaks found throughout the world are not deciduous, but are evergreen. Among all these evergreen species, only one, the holm oak, is at all common in Britain.

Above: In this country holm oaks are usually found planted as town trees, for which their resistance to pollution makes them particularly well adapted. In the south-west of England, however, where the winters are milder than elsewhere, holm oaks have become naturalised.

The holm oak is not native to the British Isles. It comes from the Mediterranean countries and was introduced here from the Cape Finisterre region of Spain at the end of the 16th century. Most likely, it was brought over here by merchants and sea captains, either in the form of seedlings or as acorns.

The tree proved successful in this country, especially in the milder climate of south-west England where it has become naturalised. In the rest of the country it is found primarily in town parks and gardens. It is particularly useful as a source of shelter in coastal areas, where its thick leathery leaves are well able to resist the drying effects of sea winds.

The name 'holm oak' comes from the old word for holly, 'holm', because the leaves of the two trees are somewhat similar. But there are several other names for this tree, including the evergreen oak, the live oak and the holly oak. Its botanical name, *Quercus ilex*, also refers to its holly-like leaves, *Quercus* meaning oak and *ilex* being the generic name for holly.

Variable leaves The leaves may have smooth margins, or may be toothed and resemble holly leaves. Frequently the leaves are also curved downwards slightly.

The colour is less variable than the shape, being dark green above and buff-grey below. The undersides are covered with tiny white hairs, as are the leaf-stalks and the young twigs.

The tough leathery leaf surface makes the holm oak unusually resistant to pollution because any dirt falling on it is easily washed away by rain. Its felted underside also helps

to keep out pollution by preventing the stomata from becoming clogged up. (Stomata are pores found in the leaf surface that allow gases to be exchanged between the leaf and the atmosphere.) This is why the holm oak grows well as a town tree.

Usually the holm oak sheds its previous year's growth of leaves in May and June, but in severe winters frost may cause the leaves to turn brown by the spring. In this case, the leaves are shed early, but the tree quickly becomes green again as the dormant buds in the leaf axils are stimulated to grow.

Flowers and fruit The male and female flowers are borne separately, though on the same tree. Male flowers are borne in catkins 4-7cm (1½-3in) long. They are inconspicuous at first but become more noticeable as their yellow pollen ripens in mid-June. Female flowers are solitary and inconspicuous. After pollination by the wind, they develop a typical acorn cup at their base in which the fruit slowly forms.

The fruit of a holm oak is an acorn. Its acorn is smaller than that of our deciduous oaks. When young it is green, sometimes turning reddish-brown when fully mature. The cup is stalked and scaly, bearing silvery-grey closely matted hairs.

In the south of England the acorns germinate quickly where they fall, but in the north and Midlands, where the climate is colder, the seed is not always viable. In these parts, you often see holm oaks grafted on to stocks of common oak.

As with all oaks, the acorns make good fattening food for pigs, although the old practice of turning out pigs into oak woods has largely died out in this country–certainly holm acorns are no longer used for food. But there is a record of pigs feeding on holm oak acorns in Surrey during the 17th century.

Timber for the Romans In its native lands the holm oak was once used extensively for making the wheels of carts and carriages, and for constructing a wide range of agricultural implements. Using the wood for wheels may well be a tradition dating back as far as the Romans. Certainly, they found it particularly suitable for this purpose on account of its hardness, durability and weight. Today, the timber is not much used around the Mediterranean, though in Algeria it is still used in carriage building and in all forms of joinery.

In Britain, the timber has never been used much, except as a source of fuel. This is probably due to the fact that common oak timber was, until recently, easily obtainable. Nevertheless, holm oak wood is very durable when used for outdoor purposes such as gateposts and stakes because, like other oaks, it contains tannic acid which preserves the wood.

There are a few instances of the wood being used in this country for construction. For example, at Munden in Hertfordshire the panelled walls of the library were made from a single tree grown on the estate. The grain is very hard and close, and slightly darker than the wood of common oak.

Holm oak (*Quercus ilex*). Introduced evergreen tree, native to the Mediterranean region. Grows to a height of 25m (85ft). Leaves unfurl in June and may be entire or distantly toothed. Flowers June.

Right: The bark of a young tree is smooth and dark green, gradually becoming scaly and fissured with age.

Above: The acorns of a holm oak are enclosed in a felted scaly cup. They are green when young, sometimes turning brown as they mature.
Because it bears acorns (and catkins) botanists classify the holm oak with the other oaks, even though to most people its evergreen unlobed leaves are quite different from the more common oak leaf. This is because botanists recognise the genus *Quercus* (ie oaks) mainly by its flowers and fruits.

Oracle for the Greeks Many trees have folklore attached to them and the holm oak is no exception. The ancient Greeks used the leaves as oracles during their ritual ceremonies. They regarded them as infallible. Crowns made from holm oak leaves were used to honour prominent citizens, and the acorns were regarded as symbols of fertility, a belief shared with other cultures. Greek women used to wear imitation acorns made of gold in the hope that they would make them fertile. They used to make these golden acorns into pendants and necklaces.

THE VILLAGE POND IN WINTER

In days gone by a pond was a vital source of fresh water for the entire village – providing livestock with a place to drink as well as water for the villagers. Today ponds, like the one below, are havens for freshwater life, especially during the winter.

The pond has been an important focal point for villages from the earliest times. Herdsmen always stopped there to water their animals, while the poor people of the village used the water for washing – cleaning not only themselves but also their clothes. Where natural ponds were found, they often provided the initiative for a village to spring up, but in many cases the pond was not natural – it had to be dug specially.

Sometimes, however, other ponds, often quite large and frequently sited on the outskirts of villages, were created unintentionally. People digging for clay to build their houses, for example, left natural depressions that eventually filled with water.

Above: A water shrew supplements its normal diet of small aquatic creatures with an earthworm. It may well have found this in the nutrient-rich base of the reeds.

Today, most ponds, no longer a vital source of fresh water, have either disappeared altogether or have silted up. Yet, for those that remain their role as wildlife habitats is still of great importance. The animals and plants that live in them have to be adaptable and capable of surviving in unstable conditions since bodies of shallow, still water can fluctuate widely in temperature and water level. They may, for instance, overflow in spring, or dry up completely in a hot summer. In particular, winter, with its cold frosty conditions, shortage of food and ever-present threat of ice, is a crucial time for the pond inhabitants.

Survival within the pond Mobile animals, such as birds, mammals and even winged insects, can escape some of the worst dangers of a freezing winter by moving away to find shelter, but for the animals that live in the pond itself, survival is not so easy. They face a strong likelihood that the pond will freeze over completely–enclosing them in an icy tomb. However, the fish in the pond do not die (unless *all* the water in the pond freezes): they slow down their activities to take account of the less abundant supply of food, and also move down among the mud and weedy vegetation at the bottom of the pond, where they are able to survive in the less heavily oxygenated water. The carp, for instance, finds its food simply by sucking up the mud at the bottom, digesting the nutritious materials contained in it, and then expelling the waste. Both rudd and tench–common inhabitants of village ponds–also become sluggish, using up a minimum of energy and oxygen.

A layer of ice can, in fact, prove to be a blessing to the pond creatures. It acts as a form of insulation, keeping the water relatively warm and thus enabling the animals to exist through the winter.

Many microscopic forms of life survive in much the same way, as do worms, pond snails and the larvae of such insects as dragonflies, caddis flies and mayflies–all finding security in the protecting layer of mud. Amphibians such as frogs and newts also join these other creatures, only emerging with the increasing warmth of spring to breed.

Plants, too, have their own winter survival mechanisms. Duckweed, for example, cannot tolerate icy, frosty conditions. During the summer it produces extra starch and stores it in its tissues. Burdened, finally, by all this extra weight, it sinks to the bottom of the pond. The starch is gradually used up by the plant as food during the winter until, when spring comes, it is once more light enough to float up to the surface.

Winter bird havens What of the creatures that live on or near the pond? Every village pond has its population of resident wild birds that do not migrate south in the winter.

Right: The kingfisher can operate successfully only if the water is clear enough for it to see the darting movements of small fish. It is therefore absent from muddy ponds.

Below: This frog spawn was laid early in the year, in February. It is not harmed by a mild frost, although the cold will slow its development. A severe icy spell would destroy it.

Above: The tench, like other pond fish, adopts a passive strategy for winter. It spends the long cold months lying at the bottom in a torpid state, hardly moving. It requires only a minimum of nourishment.

Left: The dangling yellow catkins appear early on the branches of alder, a tree that flourishes on the damp verges of ponds.

Below: A Hampshire pond in winter. Although there appear to be few signs of life, the pond at this time of year is far from dead. The mud at the bottom shelters fish, insect larvae, worms, amphibians and even plants.

Their problems during the winter months are shortage of food and lack of shelter. Birds such as ducks, coots and moorhens can, however, live on a pond as long as some part of it is fringed with plant cover in which they can hide, and provided it does not freeze over. If the pond itself cannot supply enough food, the birds forage further afield. You can often see them sitting on the ice of a frozen pond, waiting for it to melt in the winter sun.

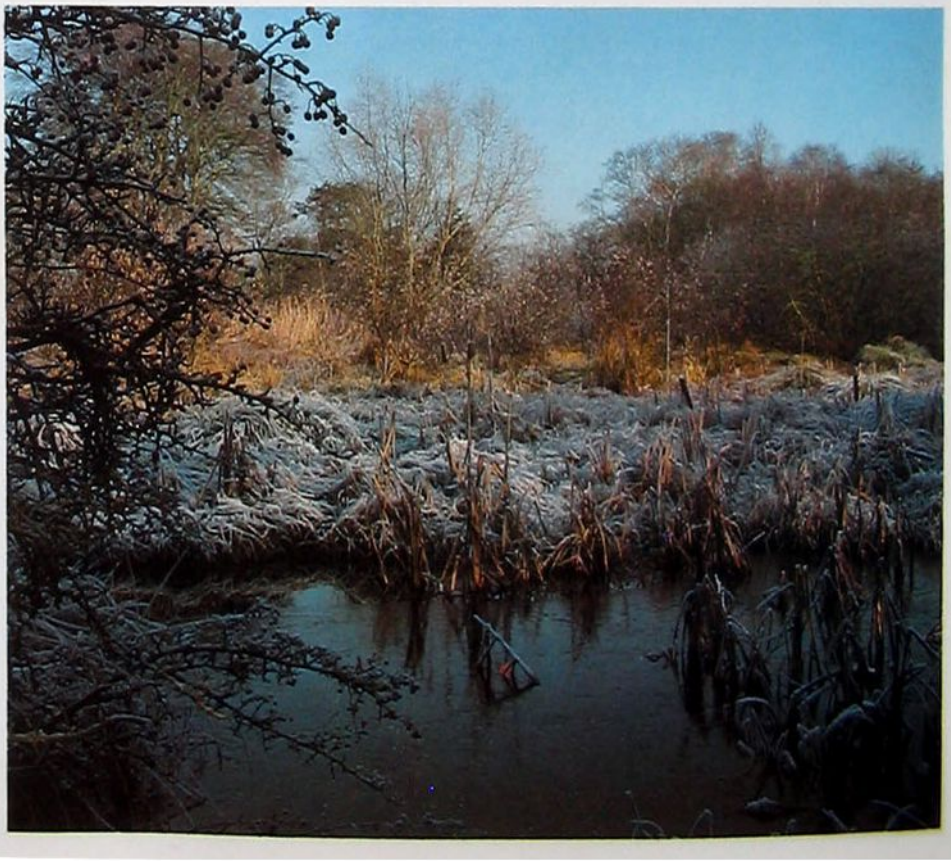
The commonest wild duck associated with the village pond is the mallard. The courtship displays of this bird reach a peak in late winter. In the first stages of courtship, a number of drakes take to the air in pursuit of a fleeing duck (female). When the duck returns to the water, the drakes circle around her, perhaps performing the 'mallard rape', one of the courtship activities. In this 'rape', several males make their way towards a duck, one of them eventually pushing her beneath the water and mating with her by force.

Birds that rely on a source of fish for food either visit the pond or live there. For the kingfisher, harsh winter weather is exceptionally hazardous. If the pond water is frozen over for any length of time, it is unable to fish, and faces starvation.

Mammal survival strategies Mammals, too, are out and about around the pond in winter. The water vole has its own way of ensuring that its home is secure if the water level rises. For most of the year its burrow is close to the level of the water. But as more water drains into the pond, and the level rises, the vole's home is in danger of flooding. It prepares for this eventuality by digging a burrow higher up the bank, into which it now moves.

Another creature which is about even in the most severe conditions is the water shrew. Like other shrews, unless it remains active throughout most of the day, it will starve to death. The shrew's sorties into the water are short, and it returns to land to eat the food it has found. Sometimes the water shrew can even be seen diving under the ice in search of the insect larvae and small snails sheltering at the bottom.

Pond plants in winter Village ponds appear bereft of plant life in winter, with nothing green showing anywhere. In one sense this is true – there are no leaves or flowers. But the perennial plants – the purple loosestrife, water forget-me-not and many others which have withered and dried – are not dead. Their roots are firmly anchored in the soft mud at the bottom, protected there, like the animals, from frost. The water itself insulates them against the worst effects of the cold. Plants with underground food storage organs, the yellow flag with its rhizome, for example, can draw on their stored supplies. Annual plants, while not surviving through winter themselves, nevertheless set seeds that are protected against frost by a hard outer casing.



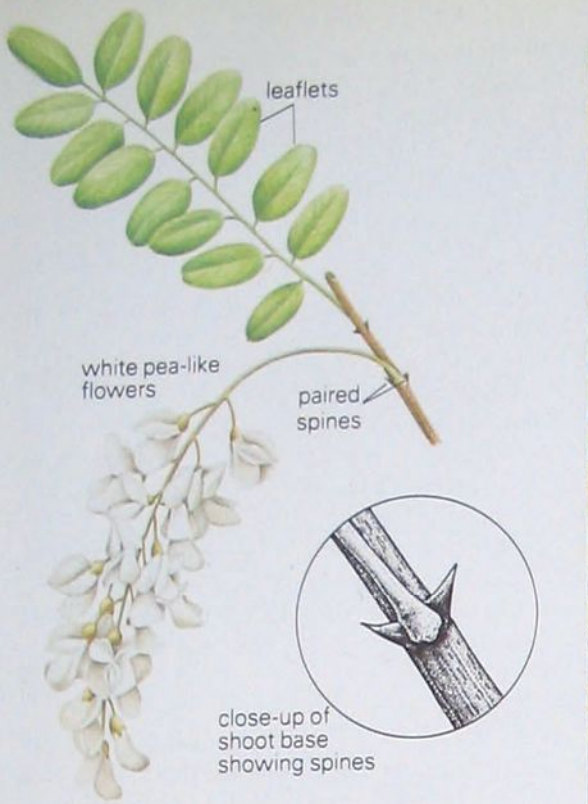
THE DECORATIVE FALSE ACACIA

In May, when it bears clusters of sweet-smelling white flowers (as above), the false acacia becomes one of our most decorative trees. Yet its popularity in Britain is due to the efforts of just one man, the journalist and MP, William Cobbett.

The discovery of the New World during the 15th century, and its subsequent exploration, led to a whole range of exotic plants being introduced into Europe. One of the first trees to be brought back was the false acacia. It was discovered growing in eastern North America by Jean Robin, herbalist to the reigning King of France, Henri IV.

Robin brought the first specimens back to France in 1601 and by 1640 it had been introduced to England. The strange tree was named the false acacia since its leaves, pods and spines give it some resemblance to the African acacia tree.

For a long time the false acacia remained a curiosity, though during the 18th century it



began to be planted in the streets, squares and parks of London. Then William Cobbett came across the tree on a visit to the United States and decided it had great potential in Britain as a source of timber.

Change of name As well as being a politician and a journalist, Cobbett was also a nurseryman and when he saw the false acacia he was much impressed by its beauty and the quality of its wood. The early settlers in America knew the tree as the locust tree, since, being biblically minded, they thought it was the same tree as that which nourished John the Baptist in the desert. They were wrong: the two trees are distinct, though they both produce pods.

On his return to England in 1823, Cobbett arranged to import seeds of the tree. He wanted it to become as common as the oak in this country, and to this end he established a nursery outside London to sell young trees to interested land-owners. He used the American name for the tree, and since then it has been known interchangeably as the locust tree or the false acacia.

Cobbett never did succeed in establishing the tree commercially, partly because its growth is too irregular in Britain for the timber to be of much general use. Nevertheless, he sold more than a million young trees, many of which can still be seen.

Zig-zag branches In the British Isles, the false acacia grows to a height of 25m (80ft). Its branches often have an irregular shape, sometimes even zig-zagging, which makes it one of the most easily recognisable of our trees from a distance.

On the young trees the bark is deep brown and smooth, but it soon becomes uneven with age and develops a characteristic network of

Above and left: The leaves of false acacia unfurl in May, followed a month later by the flowers. Each leaf consists of a central stalk holding six or seven pairs of leaflets and a single terminal leaflet. Each leaflet is rounded and has a small spine at its tip.
The flowers are white and clustered round a central stalk. The points where the leaf and the flower-cluster join on to the twig are marked by a pair of short spines.
The leaves are 15-20cm (6-8in) long; the flowers are about the same length or slightly shorter.

False acacia or locust tree (*Robinia pseudoacacia*). Deciduous, native to eastern and central North America. Introduced here in 1640. Height to 25m (80ft). Grows well on light gravelly soils and heavy clay soils, and withstands drought better than most other trees. Common in parks, gardens and streets, particularly in southern England.

Left: The flowers are followed by dark brown smooth-skinned pods. In the autumn they release small black seeds and continue hanging on the trees well into the winter.

Above: The shape of a false acacia is variable, but it is usually broadest at the top with irregular zig-zagging branches.

Left: On a young tree the trunk is dark brown and smooth, but as it gets older it develops a network of ridges and often becomes dull grey.

Below: The leaves are pale yellow when they first come out but they soon revert to their more familiar mid-green to yellow-green.

criss-crossing fissures and ridges.

The mature leaves are mid-green to yellow-green and consist of pairs of small leaflets branching off from a central stalk, with a single leaflet at the end. This sort of compound leaf is said to be pinnate. The leaves unfold late in the year–usually in May. At first they are pale yellow but they soon turn green.

In June, long panicles of white pea-like flowers appear. They have a sweet scent and are frequently visited by honey bees. The flowers are followed by the fruits: brown pods hanging in bunches. In the autumn these open to release small black seeds.

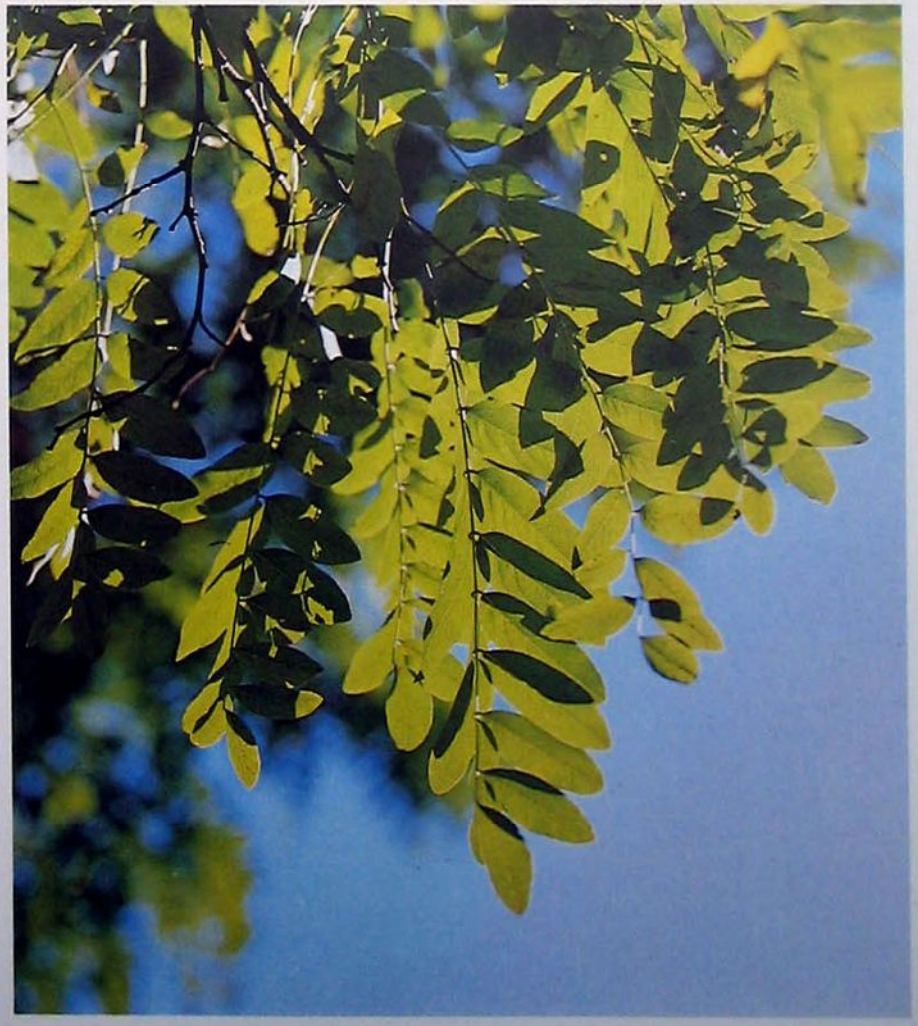
Drought-resistant Although the false acacia never succeeded commercially, it has become widespread as an ornamental tree in towns and cities, particularly in southern England. Part of its success is due to its adaptability. It grows as well on poor gravelly soils as it does on heavier clay soils. And it can withstand long periods of hot dry weather better than any of our native trees. This was borne out during the severe drought that occurred in this country during 1975–76, when the false acacia looked as green and fresh at the end of the long months of drought as it did at the beginning.

Timber as good as oak Although the timber of the false acacia has never been widely used in this country, it was at one time very popular in the United States and France, where it was regarded as being the equal of oak wood. It is certainly very tough and durable in the soil, which makes it ideal for posts and rails.

False acacia timber is also very attractive. When fresh and planed the heartwood is a glossy yellow-green, darkening to greenish-brown after a while, and it used to be a valuable furniture wood. One occasionally comes across antique furniture made from false acacia, in which the wood looks rather like satin-wood.

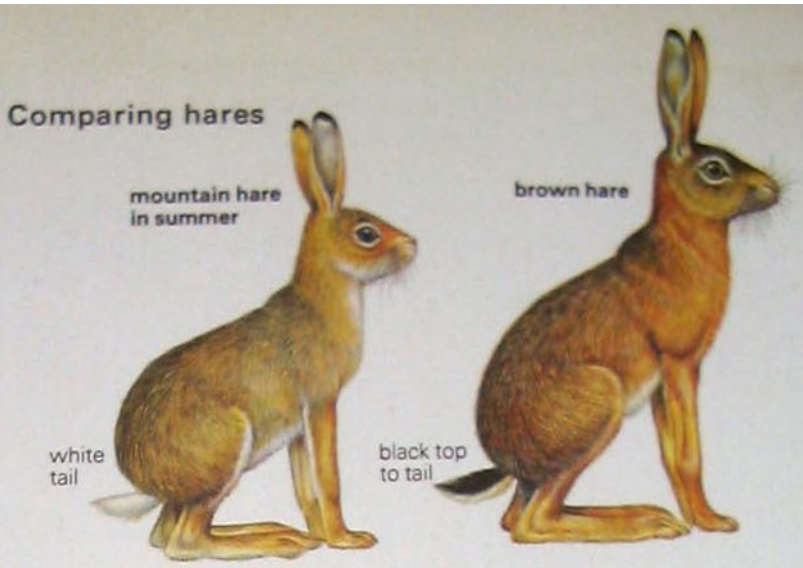
Unfortunately, the generally irregular twisting growth of the tree means that the timber is almost entirely neglected nowadays. Yet it could still be used for small-scale ornamental work.

Another potential use for the false acacia derives from its ability to stabilise the soil. All trees have this effect because their roots help to bind the soil together. But the false acacia would be particularly effective because it grows fast, tolerates poor soil and its roots spread out just below the soils surface. Combined with its great decorative value, this would be the ideal tree for planting on colliery tips, slag heaps and other unsightly places. If this were to happen, Cobbett's dream might at last come true.



HARES OF HEATHER MOORLAND

The mountain hare, a mammal of moorlands rather than mountains (despite its name), is well adapted for detecting enemies such as foxes with its long ears and good vision.



Mountain hares can be distinguished from brown hares by their appearance. A male weighs about 2.7kg (6lb), while a female is usually slightly larger at 2.9kg (6½lb); a male brown hare weighs 3.6kg (8lb), while a female is slightly heavier. A mountain hare is also greyer (hence its alternative name of blue hare, which refers to the blue-grey flank colour), and it has shorter ears and the top of its tail is not black. In winter, however, a mountain hare is strikingly different because it is mostly white or in its transitional piebald coat.

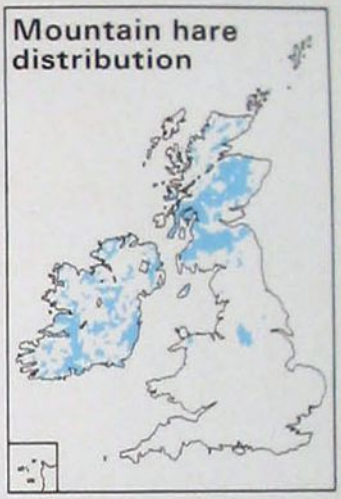
Mountains and moorlands Mountain hares are indigenous only in the Scottish Highlands and Ireland (which has no brown hares except for an introduction into the north-west). The hares were introduced to the Scottish Lowlands between 1834 and 1862, and became numerous by the end of the century. Introductions to the Scottish islands came later and were less successful. The only really successful introductions south of the Scottish border took place in Yorkshire between 1870 and 1880.

Today, mountain hares are not uncommon in parts of the southern Pennines. In Wales mountain hares released near Bangor flourished briefly but they are now rare. Irish hares, which in summer are redder and in winter become piebald rather than white, were introduced into south Scotland in about 1920. Forty years later their descendants could be distinguished from the Scottish race, which occurred in the same locality, by coat colour and incomplete moults.

Forms, scrapes and burrows The home range of a mountain hare extends between 20 and 28 hectares (50 to 60 acres), and the hare sits within this area for most of the day in a form, scrape, or at the entrance of its burrow, only leaving at dusk to begin feeding. The mountain hare makes its form in long heather by biting through the stems until it has a space big enough to crouch in without being seen, as well as being sheltered from the wind. In summer, mountain hares mainly make their forms in long heather on the lower slopes. In autumn, winter and spring they are found on the higher, more open hillsides. A scrape may be no more than a shallow depression scratched in the peat alongside a sheltering bank or boulder.

Most species of hares do not burrow, but the mountain hare digs short burrows a metre or two long, or takes over an isolated unused rabbit burrow. If disturbed by a man or a dog, the hare runs away from the burrow, usually to higher ground. The function of the burrow is uncertain. It is kept open during periods of snow, and probably the hare uses it as a shelter during storms. Leverets are not born in burrows but young leverets readily go to ground in burrows or cracks in peat.

Winter whitening In Roman times it was thought that mountain hares became white in winter by eating snow. In the wild, a mountain hare's coat begins to change colour in October. The colour changes gradually, with white appearing first on the flanks and then moving upwards, with the head not whitening until January or February, only a short time before a return to brown begins again. The winter coat is longer and denser than the autumn coat it replaces which is not moulted until the winter coat is almost fully grown, so that protection against the cold is not lost. It grows faster when the weather is colder, and is retained for longer on higher ground or in



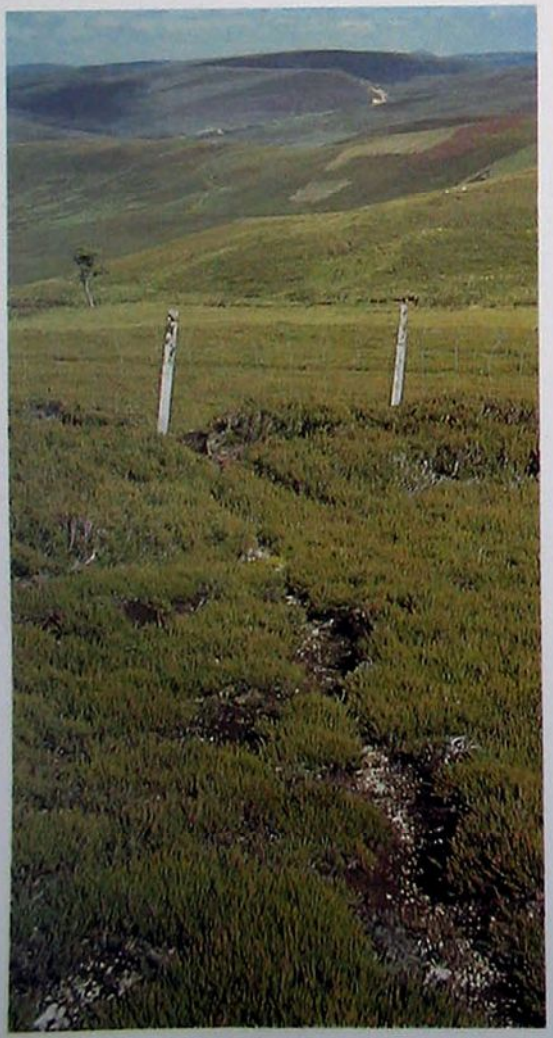
Above: Mountain hares were found originally only in the Scottish Highlands and Ireland. Their occurrence in other places is due to successful introductions.

Below: Late afternoon foray for three mountain hares on snow-covered grouse moorland in Perthshire.

Left: The heavily furred hind feet of a mountain hare leave unexpectedly large impressions in the snow. The track is rather larger than that made by this hare's lowland relative, the brown hare.

Below left: Conspicuous trails in heather are made and maintained by mountain hares biting off tender heather shoots as they move along. The uneaten pieces are discarded along the trail.

colder weather. The winter moult is in fact triggered off by decreasing daylength and can be brought about in captive hares at any time of year by shortening the periods of the hares' artificial daylight. Often, white or piebald mountain hares are conspicuous against dark heather not yet covered with snow. The spring moult lasts from mid-February to May, with the winter coat being shed freely as the new one grows. A third rather inconspicuous summer moult occurs between early June and mid-September.



Heather and cotton grass diet Mountain hares feed principally on heather, which in eastern Scotland makes up 90% of their winter diet and 50%of their summer diet. The hare prefers to feed among short heather, probably so that it can maintain a look-out for predators. With its long ears, good all-round vision and strong hind legs it is an animal adapted to identifying danger and well equipped to escape by running. Where hares are common, grazing on short heather may lead to a food shortage, and this forces some of them to move on to longer heather.

Another important plant of the mountain hare's diet is cotton grass. Its flower shoots appear early in April, about the time the first leverets are born, and provide nutritious food before the main growth of heather. In summer, mountain hares also eat moorland grasses. Bell heather or cross-leaved heath form only a very small part of their diet. When deep snow finally covers the heather, gorse, juniper, willow and rowan are important foods, with birch as a last choice. Juniper leaves, bark and twigs are all eaten on occasion. Twigs are bitten through to leave a characteristic clean sloping cut.

Winter feeding Mountain hares dig through soft snow to get at the vegetation, but if the snow becomes ice-crusted they are unable to do this and, if no protruding vegetation is available, many of them die.

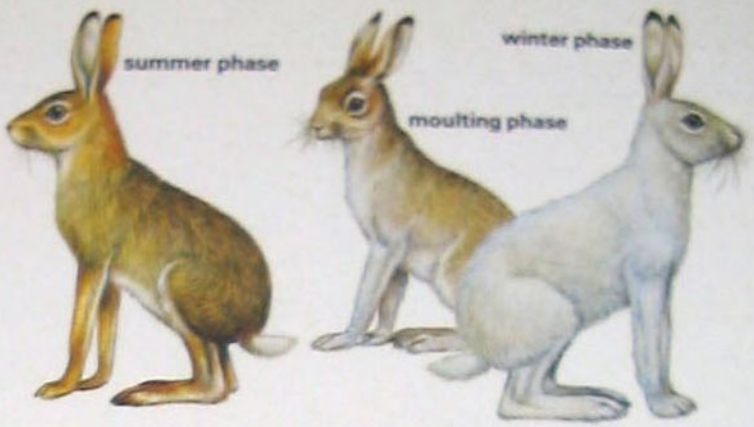
When grazing, mountain hares feed with their backs to the wind, cropping an area within an arc of 90°. Then they move one front foot at a time slowly forward, ears raised to detect possible danger. The body is then eased forward, the hind feet are brought up and the ears lowered. During storms mountain hares congregate on the sheltered side of ridges in groups of up to 40, and make scrapes in the snow for shelter. They feed intensively in daylight during or immediately preceding storms.

As with rabbits and brown hares, food is passed twice through the gut. Soft faeces

MOUNTAIN HARE (*Lepus timidus*). Distinguished from brown hare by shorter ears, greyer coat, no black top to tail and smaller size. Turns white in winter.
Weight of males about 2.7kg (6lb), females 2.9kg (6½lb).
Moults three times annually: brown to white in autumn/early winter, white to brown in spring, brown to brown from June to September.
Food principally heather in winter. In spring and summer about 50% heather, the rest cotton grass and other grasses. Usually feeds from dusk onwards, but occasionally grazes in the daytime.
Habitat heather moorland but also mountain tops in W Scotland. Commonest on heather moorland (2 per hectare/2.4 per acre), rare in W and NW Scotland (1 to 80 hectares/190 acres).
Home range on heather moorland 20-28 hectares (50-70 acres). Sits on higher ground by day in form or short burrow it digs for itself.
Breeds April-August.
Gestation 49 days. Probably three litters in each season.
Distribution indigenous in Highlands and Ireland. Introduced Scottish Lowlands and Islands, Pennines in S Yorkshire and Derbyshire. Also North Wales.

Changing coats

In mountain hares the sex with the smaller body weight – the male – is the first to start to moult to a white winter coat. This is presumably because he is more susceptible to the cold – the autumn under coat is not shed until the long, dense winter coat is almost fully grown, so protection against cold is not lost. The heavier female is the first to shed her winter coat with the approach of spring. The moult takes several weeks to complete and so the change begins before there is snow cover. This means that for a while a mountain hare can be rather conspicuous, especially to such predators as foxes.



produced by day are ingested directly from the anus. The hard pellets, the more familiar droppings, are excreted at night.

Courtship behaviour Mountain hares appear more subdued in their courtship than brown hares. At the beginning of the breeding season in February hares may be active during the day. Occasionally groups of 20 or more hares will gather in a small area from which they suddenly disperse in all directions, some of them in pairs.

Usually courtship consists of one or two males following a female at a slow lope. Eventually she stops, one of the males approaches, there is a period of confrontation in which the attitude of the ears may act as a signal, and then the female strikes with her forepaws and chases off the male.

After a gestation period of 49 days the leverets are born in the heather. Early litters, born in April, normally consist of one or two leverets, mid-season litters of two to three (occasionally four) leverets, with late season litters (August–September) down to one or two again. This gives an average production of six to seven leverets per female. Mountain hares mate as soon as their previous litter is born. When food becomes scarce the female absorbs all or some of her embryos – a useful device to ensure her survival and future opportunities to breed.

Above: Summer coat. The mountain hare sheds its spring coat between early June and mid-September. Decreasing daylight hours trigger off the winter moult, the hares' hind feet changing colour first, with the head whitening last (see below) in January or February.

Population changes Mountain hares vary enormously in numbers, with peaks occurring about every ten years. Bad weather can bring about a population crash in the spring when numbers are high and food is becoming scarce. It takes several years before numbers build up again. When numbers are less, there is more food to go around; consequently, hares live longer (many of them for more than three years), and more of them survive to breed. Since females breed annually, those that live for three or more years produce a large number of young and hares become numerous again.

There are also big differences between different moorland habitats. Moorland with a rich, healthy flora may have one mountain hare per hectare but over poor rocky moorland with sparce vegetation they are much more widely spaced out.

Enemies on land and in the air Mountain hares form an important part of the diet of red foxes on heather moorland, and the fox is in fact the chief predator. Golden eagles and wild cats also take adult mountain hares. The fox breaks up the carcase, often biting it in two just forward of the pelvic girdle, and discards the stomach but eats part of the gut. The wild cat pulls off the skin as it feeds.

THE CHARR: STRANDED LAKE FISH

The colourful charr, one of the migratory fishes we know was left behind after the last ice age, has adapted successfully to its 'prisons' in the mountainous lakes of Britain.

The charr is a member of the same family as the trout and salmon and its general features resemble those of its relatives. Its slender, streamlined body is covered with scales, its fins lack spines and it has the characteristic rayless, adipose (fatty) fin on its back just in front of its tail fin. The most obvious difference between the charr and the trout and salmon, however, is that the charr has very much smaller scales.

Brilliant colour Although relatively little known, the charr is probably the most brilliantly coloured fish in our fauna. The back is usually olive or brownish and the belly silvery white, orange or even crimson (the deep red colour being typical of males in the breeding season). Pink or orange spots are scattered along the sides and the fins, while the ventral fins are reddish with the leading edge white in contrast. Colouring may differ from lake to lake with the seasons and as the fish grows; and males in the spawning season (winter or early spring) are almost unbelievably bright.

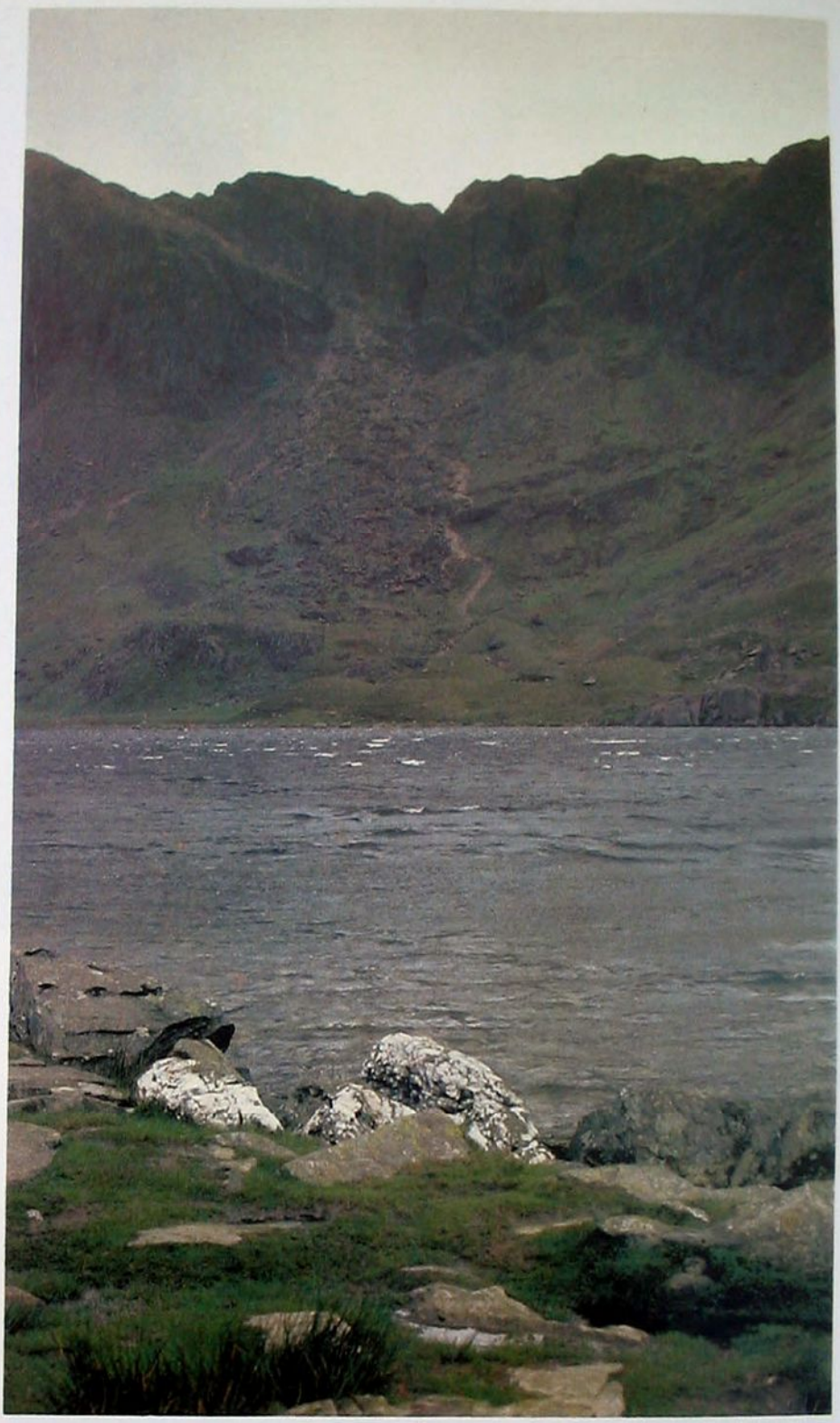
It is in recognition of this coloration that the Welsh name for charr (which live in Llyn Perris and Padarn) is *torgoch*, meaning red belly. Even the name charr may be derived from its red underside, since in Gaelic *ceara* is red and *cear* blood.

Trapped in lakes The charr is widely distributed in the mountain lakes of northern and western Britain. In Wales it is found only in lakes close to Snowdonia, and in England only in the Lake District, while there are large numbers of Scottish lochs, mainly in the Highlands, with charr in them. It also occurs on the Hebridean island of Lewis, and on Shetland. In Ireland it is found mostly in the west coast loughs. The charr's origin in the hundred or so lakes in which it occurs is of some interest, for it is believed that each population was isolated some time after the last ice age.

In Iceland and along the Norwegian coast, as well as Greenland and Canada, the charr is migratory, feeding in the sea but returning to fresh water to spawn – just as the salmon does.

During the ice ages charr were forced further south than where they are found today and it can be assumed that they were migratory off the British coast, passing from the sea into rivers to spawn. As the ice retreated further north, some are presumed to have lost their migratory habit and spent the whole of their lives in the rivers and adjacent lakes, until changes in the level of land relative to the sea trapped them in individual lakes or river systems.

This happened between 8000 and 10,000 years ago. Since then, each population has adapted to the ecosystem within which it lives. Some lakes are food-poor; some are rich in potential food. Some are deep; others are shallow. Some are acid; others, on account of the rocks around them, are alkaline. These, and other factors, have all had an effect on



Above: All native charr in Britain live in lakes in mountainous regions. In Wales the fish is found only in the lakes close to Snowdonia, such as here at Llyn Idwal. The charr has managed to exist in its often food-poor lakes for thousands of years, but its survival is precarious.

the charr, which have had to adapt to survive in the surroundings in which they found themselves.

As a result, fish from one lake may look somewhat different from those of other lakes. So great are the differences, in fact, that in the early 20th century as many as 15 different species or subspecies were recognized in the British Isles, many of which could only be identified if one knew in advance which lake they came from. The modern practice, however, is to ignore all the different names and treat the British charr as part of the species *Salvelinus alpinus*, which occurs across much of northern Europe and northern North America.

Smaller in lakes One of the most striking features consequent upon living in lakes is the small size of the charr. Few lake charr grow longer than 12in (30cm) and only in exceptionally rich lakes do they attain a weight of more than 3lb (1.3kg). In contrast, in those parts of the world where the charr migrates to the sea, it grows to a length of 39in (1m) and up to 27lb (12.2kg) in weight.

Spawning seasons Lake charr spawn in winter or early spring. In Lake Windermere the winter spawners lay their eggs in water of 3-10ft (1-3m) on gravel shallows in November and December, while the spring spawners shed their eggs in 66-96ft (20-30m) of water between February and March. Some other lakes have two spawning races, but most have just one or the other.

Their eggs are relatively large (4-5mm in diameter) and are buried in the gravel, developing slowly until they hatch in the spring. Growth rates vary enormously from lake to lake. In Windermere charr spawn at an age of five to six years, while in food-poor lakes they may be 10 or 12 years old before they mature. In the Scandinavian Arctic lakes immature fish of 20 years have been found.

Charr tend to eat whatever suitable food they can find in their home lake. In Britain this means their diet, especially when young, is confined to copepods and crustaceans (water fleas) and insect larvae, particularly midges, and freshwater shrimps. Large charr may eat other fish, but in general these tend to be scarce in the lakes inhabited by charr.

Above: The colourful charr (*Salvelinus alpinus*). There has been some disagreement about the spelling of the fish's common name. When Francis Willughby first described the populations in Lake Windermere in his *Historia Piscium* (1686), he spelt it 'charre'. In the 19th century it was corrupted to 'char', but is now spelt 'charr'.

Fight for survival Unfortunately, for all their beauty charr are always on the borderline between survival and non-survival. Several lakes known to have contained them no longer do so, among them Lough Neagh in Ireland in which they became extinct in the early 1800s.

Many of man's activities are detrimental to the survival of charr. Possibly the most harmful is the discharge of domestic or farm sewage into the lakes, this enrichment causing a change in the fauna detrimental to this fish. Another serious hazard is the introduction of other fish species to their lakes. Among these, the pike, perch and trout are obviously harmful as predators, while other fish compete for food. Acid rain, due to pollution, has also affected the delicate balance of alkalinity in some lakes and is particularly serious in Scandinavia. Water storage systems and hydro-electric schemes pose another threat. Llyn Peris and Llyn Padarn in North Wales are now used to generate electricity which may have an adverse effect on the charr population.

All over the northern hemisphere the survival of populations of the charr is under threat. Although the species as a whole is not threatened, many lake populations are. As each of these has evolved in genetic isolation for thousands of years, the loss of any one is significant bringing the charr just a little bit closer to extinction.

Below: The charr shows some similarities with its relatives, the trout and salmon. Apart from having much smaller scales, however, it also has no teeth on the mid-line of the roof of its mouth. It does have distinct and sharp teeth on the front of its palate, as do the trout and salmon which also have a staggered double row of teeth in the middle of the palate.

male charr in breeding coloration

A TRIO OF SANDPIPERS

Sandpipers are among the most dainty of our wading birds. Three species are found in Britain, of which only one is common here. The other two are migrants on their way to or from their breeding grounds.

Several species of small and medium-sized waders are known as sandpipers. They all have pointed beaks with which they probe mud for food, in typical wader fashion. But, because their beaks are not as long as those of many waders, they can also feed by pecking at morsels on the ground.

Of the three species of sandpiper found in the British Isles one, the common sandpiper, is a summer visitor and breeds here in large numbers. The other two species, the green sandpiper and the wood sandpiper, are sometimes seen in the spring and autumn on their way to or from their breeding grounds in north-east Europe. They are known as passing migrants. Both, however, occasionally breed in this country in very small numbers.

Which is which? The common sandpiper is the smallest of the three species and it has the shortest legs and neck. It has dark olive-brown upperparts, with a dark rump and tail. The underparts are white except for some brown streaks on the neck and breast.

On the ground, the most distinctive feature of this species is the way it constantly bobs its head and tail up and down. In flight, it can be distinguished from other sandpipers by a conspicuous white bar on the upper surface of each wing.

The other two sandpipers are similar to each other, especially when seen on the ground. Both have dark upperparts speckled

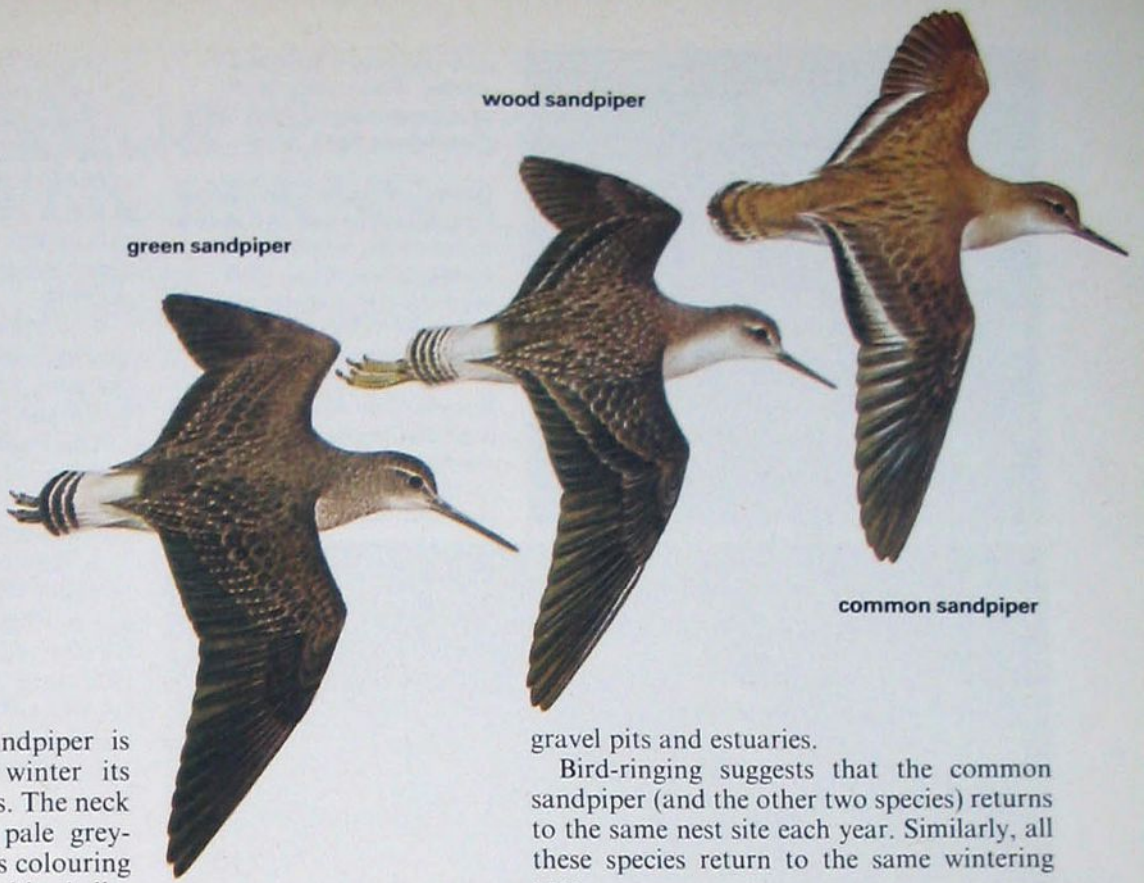
Above: The common sandpiper, seen here at the edge of a loch in Scotland, is the only sandpiper to breed in large numbers in the British Isles.

Common sandpiper (*Actitis hypoleucos*). At 19cm (7½in) long, the smallest of the three species. It is a summer visitor, arriving in April.

Green sandpiper (*Tringa ochropus*). Length 23cm (9in); the largest of the sandpipers. Passing migrant sometimes seen in spring or autumn. A few pairs have bred in Britain.

Wood sandpiper (*Tringa glareola*). Length 21cm (8in). Like the green sandpiper, usually seen as a passing migrant, though a few pairs now breed here.

Above: The common sandpiper is widespread in upland Britain and Ireland, whereas the wood sandpiper is confined to a few sites in the Scottish highlands.



with buff, though the green sandpiper is darker (almost black) and in winter its speckling is reduced to a few flecks. The neck and breast in both species are pale grey-brown; in the green sandpiper this colouring is sharply demarcated from the white belly, whereas on the wood sandpiper the two areas merge. Both species have a white rump, and a paler face than that of the common sandpiper.

The best way to tell the wood and the green sandpipers apart when they are flying is to look at their legs. On the green sandpiper they are greenish and reach only as far as the tip of the tail, or a little further. On the wood sandpiper they are yellowish and reach well beyond the tail. Another difference is in the undersides of their wings. These are dark on the green sandpiper, contrasting with its white belly, but on the wood sandpiper the undersides are buff-white. Neither species has the white wing-bar of the common sandpiper.

One final way to distinguish between the three species is by their calls. The green sandpiper gives a ringing three-note call: 'tluit-weet-weet'; the common sandpiper utters a shrill piping 'pee-wee-wee', while the wood sandpiper has a shrill repeated 'chiff-iff-iff'.

The common sandpiper In April, after wintering in Africa, the common sandpiper migrates to Europe for the breeding season. During migration it can be seen in many parts of Britain on its way to its breeding grounds, and it becomes widespread again in the autumn as it heads back to Africa for the winter. But during the breeding season it is confined to upland areas of Wales, Scotland and the north of England. It is also common in the west of Ireland.

Common sandpipers breed beside clear streams, rivers and lakes. In the spring and autumn, during migration, good lowland sites to see them include reservoirs, flooded gravel pits and estuaries.

Bird-ringing suggests that the common sandpiper (and the other two species) returns to the same nest site each year. Similarly, all these species return to the same wintering area.

Exhilarating display flight Once the common sandpiper has reached its breeding ground, the male stakes a claim to an area that will be his breeding territory and defends it against rival males.

He also needs to attract a mate. To do this he performs a display flight, flying round and round, often soaring high into the air then descending steeply with stiff or quivering wings. Sometimes a female joins him and the pair fly round and round in fast pursuit flights. During these displays the birds sing a series of rapid trills and liquid notes.

The nest is a simple hollow or scrape, sometimes lined with plant material or debris from

Below: The nest of a common sandpiper is a simple hollow scraped out of the ground, sometimes lined with vegetation and usually sited beneath overhanging plants at the side of a stream or lake. The eggs (usually four) are laid in May or June. They are pale cream, speckled with reddish- or blackish-brown. Both parents help to incubate the eggs.

Left: Common sandpiper chicks. The young of all sandpiper species can feed themselves from birth.

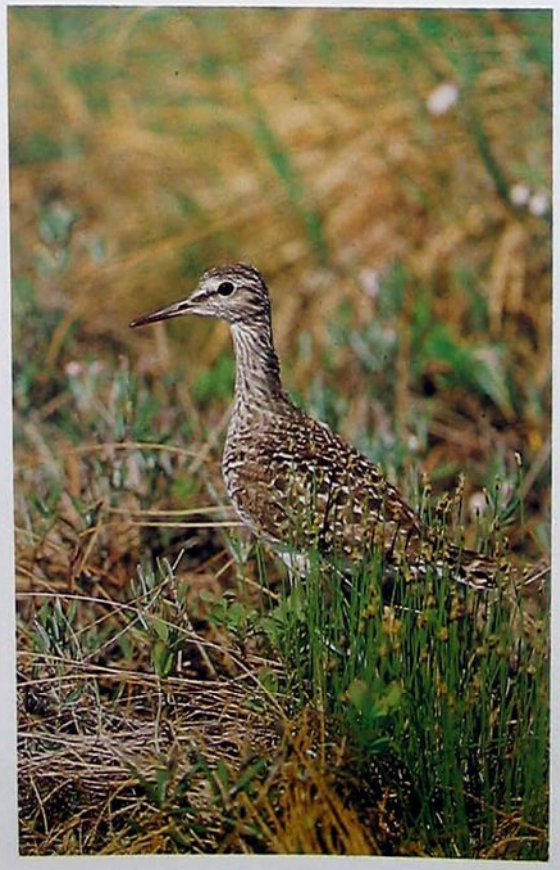
Below: A green sandpiper. Its upperparts are darker than those of the common sandpiper, and speckled white. It has a white rump (not seen here) and the legs are greenish.

Bottom: The wood sandpiper is similar to the green sandpiper, apart from being smaller and having paler legs and underparts.

Accidentals

We take for granted the skill with which migrating birds return to the same nesting place year after year. But these are the successful ones. For a few birds things go wrong. A gale blows them off course, fog confuses them, or they get caught up in a migrating flock of a completely different species. Many perish, but a few survive, eventually turning up perhaps thousands of miles from their intended destination. These lost birds are called accidentals.

Each year, accidentals are sighted in Britain, causing great interest among birdwatchers since it may be the only chance in their lifetime for them to see a particular rare species.



a river or lake. Usually it is built under overhanging vegetation.

The number of eggs laid is usually four – a typical number for a wader. The incubation is carried out by male and female equally, as is the rearing of the young. Among the three sandpiper species, only the common sandpiper shares these tasks equally between the parents.

The young are born downy and develop quickly. As soon as the down dries they leave the nest. At about two weeks old they begin to fly and a week later they are proficient.

The wood sandpiper This species is usually just an occasional visitor to these shores, resting here during its migrations in spring and autumn.

A pair of wood sandpipers was recorded breeding in Northumberland in 1853, and again four years later, but there were no further reports until as recently as 1959. In that year two birdwatchers in Sutherland accidentally stumbled across an adult wood sandpiper and two recently fledged young. A pair of birds (presumably the same ones) bred there for the next three years, and since then several new breeding sites have been found, all in the north of Scotland.

The wood sandpiper usually nests among clumps of marsh vegetation. Both parents share in the incubation, but once the eggs have hatched the female leaves the breeding area, either immediately or within a few days. This behaviour is not uncommon among waders breeding in northern latitudes. The most likely reason is that there is more food available for the chicks if one parent goes.

The green sandpiper Like the wood sandpiper, this species is an occasional passing migrant in this country, its main breeding grounds being in north-east Europe. Very rarely a pair breeds here. The last recorded instance was in 1959.

Small numbers of green sandpiper spend the winter in Britain, particularly in the south-west. They can be seen beside lakes and reservoirs, and are sometimes found feeding in the bottom of ditches and streams. The first indication of their presence is an explosive take-off and rapid flight up into the sky, accompanied by a ringing call.

The green sandpiper is unusual among waders in that it often lays its eggs in trees, using old nests of other birds. Very occasionally, the wood sandpiper also does this. The nest can be as high up as 10m (30ft) above the ground. Once the chicks have hatched and dried they have to be got down to the ground. This is done by the female calling to them from below so that the chicks jump from the nest. Being light and covered with soft down, they rarely come to any harm.

Once the chicks are a week or two old, the female leaves them in the care of the male and begins the long flight to her wintering grounds. Once the young become independent, they and the male follow on the trek south.

SPLEENWORTS: EVERGREEN FERNS

Spleenworts, small evergreen ferns that grow on rocks and walls, probably owe their continued widespread survival in Britain to the man-made habitats in which some species flourish. In fact, they seem to prefer these conditions to proper soil.

Spleenworts are ferns belonging to a very cosmopolitan group, most of which are species of *Asplenium*. However, although more than 650 different species have been named around the world, only 10 species and about 13 hybrids live in the British Isles. They therefore form a compact little group providing an easy introduction to fern identification.

Identifying spleenworts The spleenworts are all quite small evergreen plants that grow little tufts of leaves called fronds. There is a wide variety of leaf shapes which distinguishes the various species. We can identify the plants by examining the amount of segmentation of the leaf blade, the shape of the ultimate segments and the pattern of their veins.

They can also be recognised by the shape of their reproductive organs, which they all have on the underside of their leaves. These clusters of spore cases (sporangia) are oval to elongated and positioned along the veins of the leaf segments. A protective, membranous flap of tissue, the indusium, runs alongside the sporangial cluster and covers it while the sporangia develop. But, as the sporangia mature and expand fully, the indusia start to shrivel and fold back. The exposed sporangia are then free to shed their spores.

The entire reproductive unit of sporangia and indusium is called a sorus. It is the characteristics of size, shape and distribution of the sorus, and the presence or absence of indusia, that are used to distinguish the different genera of ferns. The very variable leaf characteristics are generally of little or no use for this purpose. Instead, they are features that are often of value in separating species within a genus.

Origin of name The original spleenwort from which the group as a whole received its common name, from the reputed medicinal value of the plant in treating ailments of the spleen and liver, is the rusty-back maidenhair spleenwort. This distinctive fern has its rootstock, stalks and the undersides of its leaves densely covered with black-brown scales. But it is also unusual in being able to

Below: Green spleenwort (*Asplenium viride*). This species can be found on limestone rocks in hilly or mountainous areas of northern England, Scotland, Wales and Ireland. It looks quite similar to the maidenhair spleenwort, except that its central stem is green, not brown. The spores are ripe from June to September.

survive conditions of extreme drought. It can sometimes be found shrivelled and curled up, apparently dead; but when it rains the plant expands again and begins photosynthesising. The unique qualities of its cell contents enable it to contract and survive conditions that would kill other ferns.

Common species Several spleenworts are very common and have a wide distribution in the British Isles. Plants such as the black spleenwort, the maidenhair spleenwort and the wall rue are often found growing in the crumbling mortar of old churchyard and castle walls. They appear to thrive in these situations and even seem to flourish better there than in proper soil. No doubt they have spread to these artificial man-made habitats from their natural niches in rocky crevices, where they can of course still be found, but without these artificial habitats their distribution would be much more limited.

The green-ribbed spleenwort is another species that has taken to growing on walls; but since it prefers limestone, its distribution is rather more limited. The sea spleenwort, as its name suggests, lives on rocky coasts, where it needs regular wetting by salt-spray; so it is virtually absent from sheltered shores or those where there are no cliffs. It is known as an Atlantic species, as it is absent from the coasts of eastern England south of Yorkshire.

Rarer plants Other species have an even more restricted distribution. The lanceolate spleenwort (*Asplenium billotii*) is mainly restricted to coastal areas in Wales and south-western England, while the forked spleenwort is largely confined to the older acidic rocks of North Wales and the Lake District.

The remaining two species are even rarer. The serpentine black spleenwort (*Asplenium cuneifolium*) is, as its name suggests, a plant of serpentine rocks. It is found in Scotland and at one site in western Ireland, while *Asplenium onopteris* has been recorded definitely only in south-western Ireland. This last species has only recently been fully recognised as a separate entity from the black spleenwort, which means that it has never had its own common name. It is thought it may yet be found to have an even wider distribution. The two differ only in minute details of their leaf segmentation, so there has been some disagreement over whether the two species really are distinct. But the black spleenwort has been shown to have twice the number of chromosomes as the other, which is generally accepted as proof of species individuality. This is a good example of how increased botanical knowledge of cytogenetics enable us to understand fully the complexities of some plants.

Hybrids Spleenworts hybridise very easily – an indication to fern specialists that the group consists of genetically closely related species. In evolutionary terms, this means that new species have probably been formed due to ecological or geographical isolation, rather than reproductive isolation. For similar reasons, the ability to hybridise regularly is also found in a number of flowering plant groups such as the orchid and the daisy family.

Several kinds of hybrid spleenworts have been found in the wild and have therefore been given their own scientific names. Very few fern hybrids are common enough to have received their own Latin names, although the alternate-leaved spleenwort (*Asplenium* x *alternifolium*) is a notable exception. This spleenwort is a hybrid of the forked and the maidenhair spleenworts. It is very rare, being found in a few rocky areas of North Wales, Somerset, the north of England and the south-east of Scotland.

Hybrids arise from the fusion of a sperm cell from a prothallus of one species with the egg cell in the prothallus of another species. As might be expected, the resultant plant shares characteristics of the parents and is usually somewhat intermediate in appearance.

Left: Forked spleenwort (*Asplenium septentrionale*). Rare, on rock in northern mountains. Fronds 5-15cm (2-6in) long.

Sea spleenwort (*Asplenium marinum*) Fronds 8-50cm (3-20in) long.

Rusty-back maidenhair spleenwort (*Asplenium ceterach*). Fronds 5-23cm (2-9in) long.

Wall rue (*Asplenium ruta-muraria*). Fronds 2-15cm (1-6in) long.

Black spleenwort (*Asplenium adiantum-nigrum*). Fronds 10-45cm (4-18in) long.

Right: Maidenhair spleenwort (*Asplenium trichomanes*). Common on rocks and walls in western areas. Fronds 5-35cm (2-14in) long.

MOTHS THAT EAT CLOTHES

Have you ever found ragged, unsightly holes in any of your woollen or fur garments? House and clothes moth caterpillars are the culprits – they thrive on these natural fibres.

Over 2000 different species of moths are found in the British Isles and 90% or more of them feed, in their caterpillar stage, on living green plants, usually on the leaves, more rarely on the roots and stems. But there are two families of small moths whose larvae live on dry, dead foodstuffs that are indigestible to most other animals. The caterpillars of house moths (family Oecophoridae) and clothes moths (family Tineidae) live on dead wood, dried out lichens and fungi, feathers in birds' nests and the skin or fur of dead animals.

Originally, these moths specialised in living in old birds' nests and the nests of bees and wasps, but houses are an ideal habitat for them. They are kept warm throughout winter, so the moths need no hibernation stage, their life cycles continuing all year round. Two or three generations of clothes moths can appear each year and the adults can be found at any season.

Identifying house moths Most of the moths you see in a house are not house or clothes moths. They are harmless, night-flying species that have been attracted to a lighted window and become trapped indoors. Unless they can get out again they are doomed since there is no food for them, and no foodplants for their caterpillars.

True clothes and house moths are small – usually no longer than 7-12mm (¼-½in) – whereas most outdoor moths that blunder indoors by accident are much larger. Even if size does not distinguish them, however, behaviour will. When disturbed an outdoor moth flies towards the brightest light there is, but house moths often do not fly at all when disturbed, preferring to scuttle away and hide.

Adult house and clothes moths have no functional tongues and cannot eat or drink. The same applies to many outdoor moths, such as winter moths, which have very short adult lives. The surprising thing is that house moths can live for up to a month as adults, relying completely on the foodstores in their bodies laid down in the caterpillar stage. The whole of the food supply for their life cycle is provided by the dry diet of the caterpillars – it is these, and not the adults, that do so much damage to fabrics.

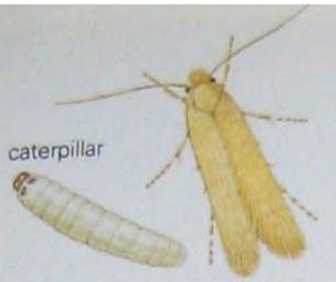
Above: The white-shouldered house moth (*Endrosis sarcitrella*) is easy to recognise because of its white head and front part of the thorax.

Some common species The brown house moth, recognisable by its brown colour and the three black dots on each forewing, is common in houses throughout the British Isles, appearing from May to September. The white-shouldered house moth is easy to identify because it has a white head and front part of the thorax; its wings are much the same colour as those of the brown house moth.

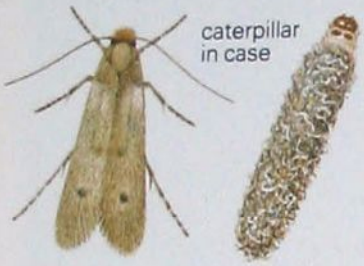
True clothes moths are different in shape from house moths. If you look at a clothes moth from the side you will see that around the tip of each forewing there is a row of long hairs that rise up above the level of the head and body of the resting moth. The common clothes moth is smaller than the brown house moth at about 7-8mm (¼in) in length, and is a shiny golden brown colour. The adults are out and about at most times of the year, but are commonest in summer and autumn.

Three other kinds of true clothes moth are

Below: The brown house moth (*Hofmannophila pseudospretella*) is the commonest of three species belonging to the Oecophoridae family that frequent houses. The brown colour and the three black dots on the forewing help to identify it. The adult moths are common from May to September.



The common clothes moth (*Tineola bisselliella*). The adults are common in summer.



Clothes moth (*Tinea pellionella*). The caterpillar makes a portable silk case.

The tapestry moth (*Trichophaga tapetzella*).

Left: House moth caterpillars burrowing in a carpet. The caterpillars of all house moths and clothes moths are similar in appearance, with dark heads and whitish-grey bodies. They tend to live in dark places and have not evolved camouflage colours. These caterpillars can cause thousands of pounds worth of damage a year. They cannot damage nylon and other artificial fibres and the increasing use of these may have reduced the amount of damage. On the other hand, the higher proportion of houses with central heating means the moths may breed faster and cause even more destruction.

Caterpillar silk

Clothes and house moth caterpillars make cases and tubes out of silk – but where does the silk come from? All caterpillars have a pair of highly modified salivary glands, the ducts of which lead to a special organ, the spinneret, situated on the labium, or lower lip. Silk, produced in two 'threads' from the glands as a fluid, is forced out through the spinneret. Sticky, quick-drying secretions from another gand, the accessory gland, are also produced and help the silk to harden and the two threads to adhere to each other. The silk is used by caterpillars to make protective 'tents', life-lines and the cocoons inside which moths pupate.

fairly common in Britain. Two of them, *Tinea pellionella* and *T. pallescentella*, are a little larger than the common clothes moth and have dark spots on their brownish wings. The adults are very similar to each other, but their behaviour in the caterpillar stage distinguishes them. *T. pellionella* is a case-bearing clothes moth; the caterpillars each make a portable silk case that protects their bodies – rather as a caddis case protects the caddis fly larva. *T. pallescentella* does not make a portable case. The other fairly common species is the tapestry moth; it has black and white wings which make it look rather like a bird dropping. It more often lives in outbuildings rather than dwelling houses.

Life cycles The female common clothes moth mates soon after she hatches, then spends about three weeks finding places to lay her 40 to 70 eggs. During this time she stays well hidden in the undisturbed corners that are the feeding sites of her caterpillars. The moths you find on walls and curtains are males, or old females that have already laid their eggs. Killing adult clothes moths when you seen them is not, therefore, an effective way to protect your woollies!

The eggs take between one and five weeks to hatch, depending on how warm it is. In fact, the whole life cycle is temperature-dependent: in a centrally heated house it can be completed in four months, but in cold outhouses with a poor supply of food, the caterpillar stage alone can take four years.

Although the common clothes moth caterpillars do not make portable silk cases like the case-bearing clothes moth, they often, but not always, spin a silk tube among their food. This tube is open at each end so that the caterpillar can reach out to feed. Instead of making a silk tube they sometimes just stay hidden in the wool they are eating.

Moisture maintenance A clothes moth caterpillar lives on dry food in a very dry habitat and yet it is able to maintain the moisture in its body. Wool, hair and feathers are made of a hard protein called keratin which is completely indigestible to all mammals and most insects, but clothes and house moth caterpillars have a special enzyme in their guts which can break down the keratin to produce nourishment and moisture that they need to survive.

The thin white skin of the caterpillar does not look waterproof but it is. An invisible layer of wax less than $\frac{1}{1000}$mm thick covers the surface of the skin and renders it quite impermeable. It is this waxy layer that enables the caterpillar to stop its body fluids from drying out; if the wax is damaged by abrasive dust the caterpillar dries out and dies in just a few hours.

White-shouldered house moths also have caterpillars that make silk tubes, usually with bits of food and droppings mixed in with the silk. Like the brown house moth, they are not quite so efficient as clothes moths at living in dry habitats and are most often found in slightly damp drawers, under soft furniture cushions or padding, and in cellars. In cellars they can cause a great deal of damage by eating the corks in stored wine bottles.

Preventing moth damage House and clothes moths often first enter house via birds' nests built under roof eaves and in lofts. One way to prevent damage is to avoid storing old clothes and woollen articles in the loft where they are almost certain to attract the moths and cause a build-up in their populations. The old-fashioned felt pipe lagging is also a favourite caterpillar food, but the modern glass fibre insulation is safe from attack.

Clothes in regular use, and carpets and curtains in rooms that are in use and cleaned fairly often, are all quite safe. It is stored woollens and furs that are really in danger. Proprietary anti-moth crystals in drawers and wardrobes will help, and you can protect items which are free of moth caterpillars and eggs by sealing them inside polythene bags so that the adult moths cannot enter and lay eggs that hatch into destructive larvae.

HEATHLAND NATURE RESERVE

Studland in Dorset is one of the finest examples of lowland heath in the British Isles. It is endowed with a rich variety of rare animals and plants whose futures are assured so long as Studland remains a protected nature reserve.

Below: A view of the nature reserve from the south. Nearest lies a large area of heath, with the peninsula further away, its freshwater lake gleaming in the middle. In the distance are Poole and Bournemouth.

At the beginning of the last century much of the land between Dorchester and Southampton was covered with heath, about 30,400 hectares (75,000 acres) lying within the modern boundaries of Dorset. Less than one fifth of that now remains, and the losses continue at the startling rate of over an acre a day. Heaths have disappeared under the town of Bournemouth and Poole. Others have been converted into pastures, conifer plantations and rubbish tips, and some have been ravaged by army tanks or the excavation of sand and clay. Now there is another hazard – oil exploration.

The remaining fragments of heath are widely dispersed. Many of them are too small to hold significant populations of the rarer wildlife species, and too isolated to be recolonized from elsewhere. A few comparatively large blocks, however, survive in the Isle of Purbeck, to the south of Poole Harbour, and the largest of these is Studland Heath National Nature Reserve, with an area of about 630 hectares (1557 acres). It is in the care of the Nature Conservancy Council.

Nature reserve Over a third of this area has been a reserve since 1962, most of it forming part of what is known as the South Haven Peninsula. This name was coined by the late Captain Cyril Diver, who carried out an

Above: The grayling is a handsome butterfly, its brown and buff wings marked with eye-like spots. It is seen here on flowering bell-heather, but when it settles on bare ground it seems to vanish as soon as it alights; showing little more than the underside of one dull-coloured hind wing, it melts perfectly into the background. The grayling adds the final touch to its disappearing act by leaning over at exactly the right angle so that it casts no shadow.

excellent ecological survey here in the 1930s, and it applies to a finger of land lying between the saltings of Poole Harbour and the sandy beach of Studland Bay. It extends northwards to South Haven Point, where a ferry takes motor traffic across the narrow harbour entrance to Sandbanks, now the southern tip of the greatly expanded Poole and Bournemouth conurbation.

Only a part of the peninsula is heathland. Broadleaved and coniferous woodland, scrub, sand dunes and wetlands make up the rest, while in the centre lies the Little Sea, a freshwater lake bordered by reedswamp, acid marsh and sallow carr. It is an important refuge for wildfowl, especially in winter, when over 2000 duck of 12 or more species can be present. Captain Diver's research showed that the sand dune system, which lies to the north and east of the lake, has only developed over the last four centuries. Building against the northern and southern ends of the narrower original peninsula, it gradually enclosed a saltwater lagoon, which eventually became the freshwater lake we see today.

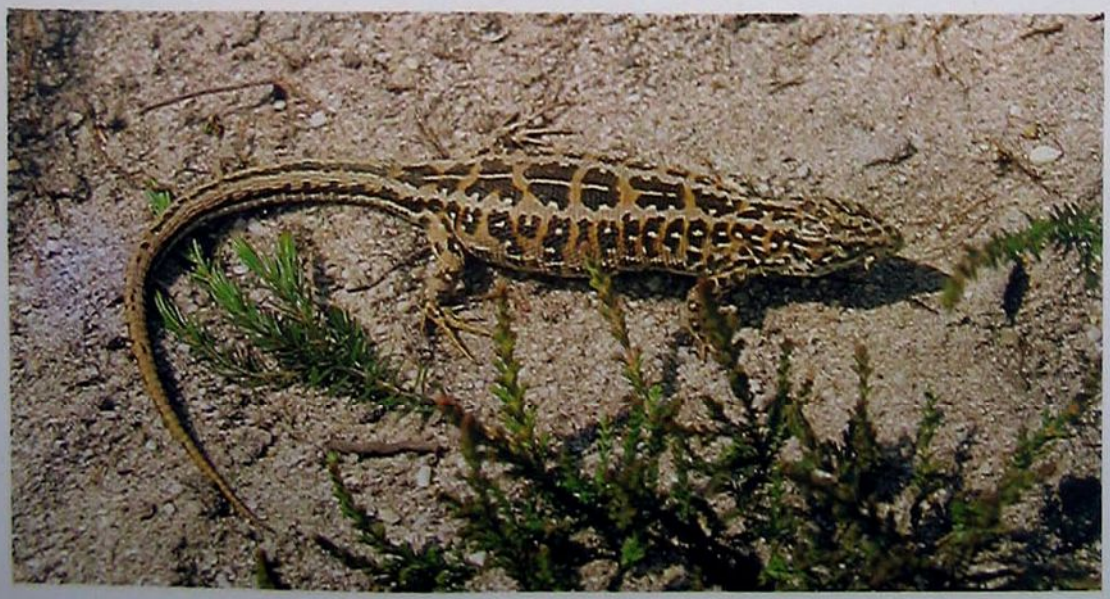
In November 1980 the reserve was extended to include a much greater expanse of heath, containing several valley bogs of great botanical and entomological interest.

Dry heath On the better-drained ground, heather or ling is the dominant plant, mixed here and there with the earlier-flowering bell heather, and dwarf gorse, which flowers in late summer and autumn. The much taller common gorse, which also occurs here, is usually considered to flower the whole year through – hence the saying that kissing is in season when gorse is in bloom – but in Purbeck it makes a somewhat poor show in August and September. This, however, is the time when dwarf gorse is at its best, and it is joined by a second autumn-flowering species, the western gorse. This is mainly found on the west side of Britain, but in East Dorset its range overlaps with that of the dwarf gorse.

Gorse and heather are important to many of the heathland animals. Heather flowers are much visited by ants and bees, and one species of ant, *Tetramorium caespitum*, collects and stores the seeds. In the spring it feeds them, after chewing them into a soft pulp, to its grubs. The heather shoots are consumed by caterpillars of the silver-studded blue butterfly and several kinds of moth, including the oak eggar, fox moth, emperor moth, common heath, beautiful yellow underwing and true lover's knot.

Heather also supports plant life. One of the many heathland lichens, *Parmelia physodes*, grows on its woody stems, and sometimes whole tussocks are festooned with the reddish threads of dodder, a plant parasite which may also be found on dwarf gorse.

In spring the gorse flowers attract the green hairstreak butterfly, which lays its eggs on the petals, and on autumn mornings the bushes are hung with hundreds of dew-laden webs of the hammock spider, one of the many species of spider that prey on heathland invertebrates.



Left: A sand lizard displays its attractive markings. It is an inhabitant of the dry heaths and the sand dunes, for it cannot live in a place where there is no access to sand in which it can lay its eggs. The lizard feeds on the plentiful insect population of these habitats. It occurs in Dorset, Hampshire and a remote colony surviving in the north-west of England.

Lasius alienus, another heath-dwelling ant, collects the seeds of dwarf gorse and may well help to spread the plant. It eats a part of the seed which contains oil, leaving the rest undamaged and still able to germinate.

Ants play a vital part in the heathland ecology. Not only do they exploit the vegetation directly, but also indirectly by taking honeydew from sap-sucking aphids. In the absence of earthworms (which are not so numerous in the acid soil of the heaths as they are elsewhere), the ants are the most important soil excavators on the heath, and their mining activities improve the soil structure, to the benefit of the vegetation. They prey on a wide range of invertebrates, including other ants, and they can dispose of the occasional dead mammal, bird or reptile which they might find lying on the heath.

Bare ground Here and there are areas of bare sand–trackways, eroded slopes, excavations or the site of a serious fire. Such places are haunted by that fierce and fast-moving predator, the green tiger beetle, by various mining bees and sand wasps which burrow into the banks, and by the grayling butterfly.

Bare ground is often a convenient spot for reptiles to bask in the sunshine: the rare and beautiful sand lizard, which also needs bare sand in which to lay its eggs, and Studland's other reptilian speciality, the smooth snake. Both these animals are on the danger list, and have been given protection under the Conservation of Wild Creatures and Wild Plants Act of 1975. Smooth snakes are, of course, harmless, and it is particularly sad that they should sometimes be killed in mistake for adders–even the killing of an adder is to be regretted in any case.

Birds A small bare or lichen-covered patch on the dry heath might provide a nesting site for the nightjar. This is a bird of the twilight. It spends the day time resting on the ground or perhaps a fallen tree branch, looking exactly like a piece of dead wood, but after sunset its low-pitched 'churring' song vibrates across the heath, and its silhouette may be seen gliding, floating and even hovering, in pursuit of moths, beetles and craneflies.

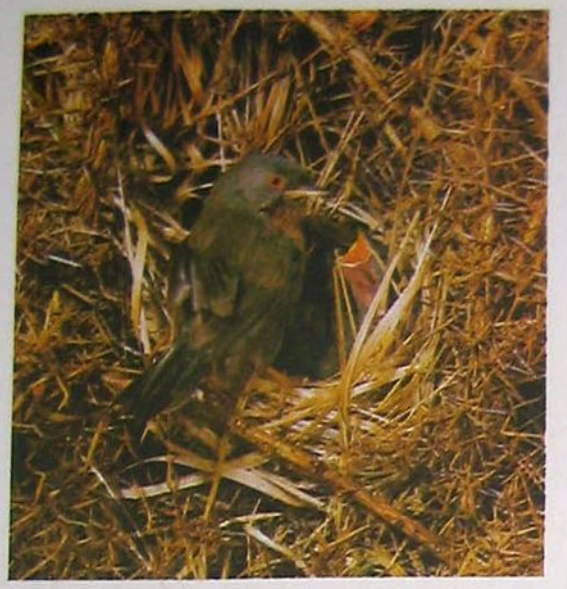
Birds are far from numerous on the heath, and the only species one is certain of seeing is the meadow pipit. Stonechats frequent some of the gorse patches, whereas the Dartford warbler, also found here, tends to conceal itself.

Wet heath The main botanical interest of the Dorset heathland lies in the wetter ground –the valley bogs, the bog pools, and the ill-drained slopes and hollows where the underlying deposit is of clay. Cross-leaved heath is the characteristic plant of these areas, but the rare Dorset heath is also found, often hybridising with the former species. In a number of places in Purbeck the Dorset heath is near to being abundant, but nationally it is an extremely uncommon plant. Outside a restricted area in Dorset it occurs (in the British Isles) only at a few places in Cornwall, at one site in Devon, and in Connemara, Ireland. It is seen at its best in August and September, when the marsh gentians also appear. These are usually similar in colour to the spring gentian, with their deep blue trumpets, but occasionally a white one may be seen. The popular name is inappropriate, for this is not a plant of marshes, but of damp heath. At Studland it has a long flowering period, lasting from mid-August to early November.

The wetter ground is often covered with purple moor-grass, which provides nest-sites for the harvest mouse, the charming animal

Above: Resplendent with its green back and pink legs, the green tiger beetle is a fast running hunter of insects and other small animals on the heath.

Below: The bog asphodel is a member of the lily family, and grows from a rhizome in the wet ground of the hollows and in the valley bogs. It can spread into extensive patches, colouring the bogs with bright yellow in July.



Left: The Dartford warbler, breeding in the gorse thicket, is one of the most interesting species in Studland. It stays here and in other lowland heaths of southern England all through the winter. However, this is only the northernmost tip of its European range, and although the climate here is mild in comparison with elsewhere in Britain, an unusually hard winter can bring death from exposure and a catastrophic fall in its numbers.

Studland's varied habitats

usually shown in pictures clinging to a corn stalk. It is in fact an animal of tall grasses of all kinds, and not only the ones that we cultivate as cereals. The stems of the purple moor-grass are too weak to support the nest in the usual way, and it is therefore constructed in the yellow mass of dead leaves at the crown of the grass tussock.

Where there is a mixture of cross-leaved heath and purple moor-grass, you are likely to find two bush-crickets, the rather attractive brown-and-green bog bush-cricket and the short-winged conehead. They look superficially like grasshoppers, but have long antennae and the females have an ovipositor (egg-laying organ) shaped like a sword scabbard. Close examination of the flowerheads of cross-leaved heath may reveal the presence of a pink crab-spider, *Thomisus onustus*. Its colouring matches that of the flower, and it is ready to seize any unfortunate insect that is deceived by this resemblance. Amongst the predators operating at a lower level in this environment is a metallic green-and-red ground beetle, *Carabus nitens*.

Acid bogs Wet heath grades into bog, a spongy, shaking expanse of sphagnum moss with occasional pools. Bog cotton and the pleasantly aromatic bog myrtle grow here, and in July large areas are yellow with bog asphodel. Here are Britain's three species of sundew, plants which compensate for the poverty of the soil by digesting animal matter: they trap invertebrates with the sticky, enzyme-secreting hairs on their leaves. Other carnivorous plants which occur at Studland are the pale butterwort, which grows on the wet heath, and bladderwort, which is found in the bog pools.

These pools are inhabited by palmate newts and by various aquatic insects and their larvae. Dragonflies and damselflies are well represented, and of particular note are the handsome, but not uncommon, black sympetrum (*Sympetrum scoticum*) and, a southern rarity, the small red damselfly (*Ceriagrion tenellum*). While these and others patrol the air above the pools, the water surface itself is the hunting preserve of the raft spider (*Dolomedes fimbriatus*). This, in body size though not in leg-span, is the largest of our spiders, and it makes short work of any insect falling into the water.

Access The Studland Heath National Nature Reserve is freely open to visitors, but it is as well to keep mainly to the paths and trackways, some of which have been made by the resident roe deer. In this way you can avoid the discomfort of walking up to your knees in the bog, or causing unnecessary disturbance to ground-nesting birds and other wildlife. You should always be aware, too, of the serious fire hazard. There is so much of value in Studland that needs the watchful protection of warden and visitor alike, for this beautiful heathland deserves our greatest respect.

OUR MAGNIFICENT CEDAR TREES

The first cedar trees were introduced to this country from the Middle East about 300 years ago and soon came to be regarded as our most decorative conifers. Today you can find them planted in parks and gardens in most parts of Britain.

Above: A grove of stately cedars of Lebanon at Attingham, near Shrewsbury. This was the first species of cedar to be brought to this country and it is still the most widely known, partly because of the many biblical references and partly because of its unusual shape. The flat top and layered branches of a mature cedar of Lebanon are quite distinct, even when compared to other cedars, and make this tree perhaps the handsomest of all our conifers.

As well as the familiar cedar of Lebanon, there are three other species of cedar, all of which are native to the Mediterranean or the foothills of the Himalayas. Two of these, the Atlas or Atlantic cedar and the deodar, are as common in this country as the Lebanon cedar. The third species, the Cyprus cedar, is seldom found here. However, it is the cedar of Lebanon that comes to most people's minds when asked to name a cedar.

Timber for Solomon's palace The familiarity of the cedar of Lebanon is probably due in part to the number of times it is mentioned in the Bible–more times than any other tree. The timber was highly valued in Palestine in Old Testament days (it still is), and was once used for building Solomon's palace and the Temple of Jerusalem. Such was the demand for the wood that whole forests were cleared, reducing the landscape to desert.

Now the Lebanon cedar is limited in its natural distribution to south-east Turkey and Mount Lebanon in Syria. The grove of trees on the slopes of Mount Lebanon (after which the tree is named) is thought to be extremely ancient. Legend has it that Solomon's palace was built from cedars growing in this grove.

The cedar of Lebanon was introduced to Britain in 1638. In the 18th century, with the advent of landscape designers such as 'Capability' Brown, it became popular in the parklands and gardens of country houses. Its evergreen habit and large spreading branches added a new shape to the English countryside.

Deodar and Atlas cedars It was almost a hundred years before the next cedar species, the deodar, with its paler foliage and drooping branches, was introduced to Britain. The deodar is native to the western foothills of the Himalayas, where the tree is valuable both as a source of timber and for the way that its roots hold the soil firm to control erosion during the monsoon rains. The deodar was introduced to this country in 1831 and soon found its place in formal garden design.

The introduction of the deodar was fol-

Left: **Lebanon cedar** *(Cedrus lebani)*. Introduced evergreen, native to the eastern Mediterranean. Common in parks, large gardens and churchyards. Grows to a height of 40m (130ft).

Below: Male cones on a Lebanon cedar. They are about 5cm (2in) long and stand erect on the shoots. They ripen in the autumn, releasing clouds of yellow pollen to fertilise the inconspicuous green female cones.

Left and below: The cones of all three species are erect and barrel-shaped, those of the Atlas cedar being distinguished by a hollow in the top. All shed cone scales to leave a bare central stem.

Right: **Deodar** *(Cedrus deodara)*. Introduced evergreen, native to the western Himalayas. Often distinguished from other cedars by its drooping branch tips. Common in parks and gardens. Height to 35m (120ft).

lowed closely by that of the Atlas or Atlantic cedar, brought over here in 1841. This species is native to the Atlas mountains of Algeria and Morocco. It quickly became more popular than the deodar, and is now often seen planted next to a cedar of Lebanon, sometimes in its green-foliaged form but more usually in its blue form, known as the blue cedar. Blue cedars occur naturally in the Atlas mountains and are now particularly popular in suburban gardens.

Also from the Mediterranean, but limited to Cyprus, comes the Cyprus cedar. This species has smaller leaves than the other cedars. It was introduced in 1879 but is seldom seen in Britain, though it forms fine forests in the Troodos mountains of Cyprus.

Which is which? In Britain, cedars are easy to identify since their dark evergreen leaves occur as rosettes: bundles of leaves emanating from short shoots. Other conifers have rosettes of leaves, but only in the larch do they resemble those of the cedar. The larch and cedar are easily distinguished by their cones and the fact that the larch is deciduous.

However, it is not easy to distinguish one cedar species from another. Indeed, they are so similar that they should, perhaps, be regarded as different forms of the same species. The Atlas and Lebanon cedars are particularly easy to confuse. A useful way to tell them apart, especially with young trees, is

by their shape. The Atlas cedar has ascending branches; the deodar has drooping branch tips and a drooping leading shoot (the shoot at the top of the tree); the Lebanon cedar bears its foliage in horizontal layers. A good way to remember this is the mnemonic: *A*tlas *a*scending, *d*eodar *d*rooping, *L*ebanon *l*evel.

Leaves and cones The current year's growth of twigs bears single leaves, which drop off after about a year. Thereafter, the twigs develop the rosettes described earlier. These contain between 10 and 20 leaves and remain on the tree for between three and four years before falling.

The leaves of the Lebanon and Atlas cedars are about 2cm ($\frac{3}{4}$in) long. On the deodar they are longer: 3-5cm (1-2in). The leaves of the deodar are also softer and a lighter colour green.

The young cones appear in the autumn. The male cones stand erect on the branches and shed their pollen to fertilise the smaller inconspicuous green cones.

The female cones mature into brown barrel-shaped cones. Unlike those of most other conifers, cedar cones remain upright on the branches as they mature. The ripening process takes two to three years, after which the cone scales are shed to disperse the seed contained inside, leaving a woody stalk standing on the branch.

Bark and growth rate The bark of all cedar species is alike: dark grey and smooth when young, breaking into flat scaly plates as the tree grows and the trunk expands.

Because cedars are planted in open parkland rather than in crowded woods the increase in their girths is about the same from year to year. This growth rate depends in part on the soil conditions and the rainfall, but 30cm (1ft) every five years is average. So a tree with a girth of 6m (20ft) would be about 100 years old.

Young cedars are fast-growing trees, but with age, they slow down and the tops spread out. In Britain they do not grow higher than 40m (130ft), which is less than many other conifers growing here.

Cedars live for a long time, given the chance, but with age they often become dangerous. This is because growing in open parkland encourages the trees to develop large heavy branches that are prone to fall off, particularly if rainwater gathers in the angle between the branch and the main trunk, encouraging rot to set in.

To prevent this from occuring, large branches are often removed from old trees, though it is better to fell the whole tree. Cedar trees much more than 150 years old are frequently dangerous and unsightly and are better replaced with young vigorous trees.

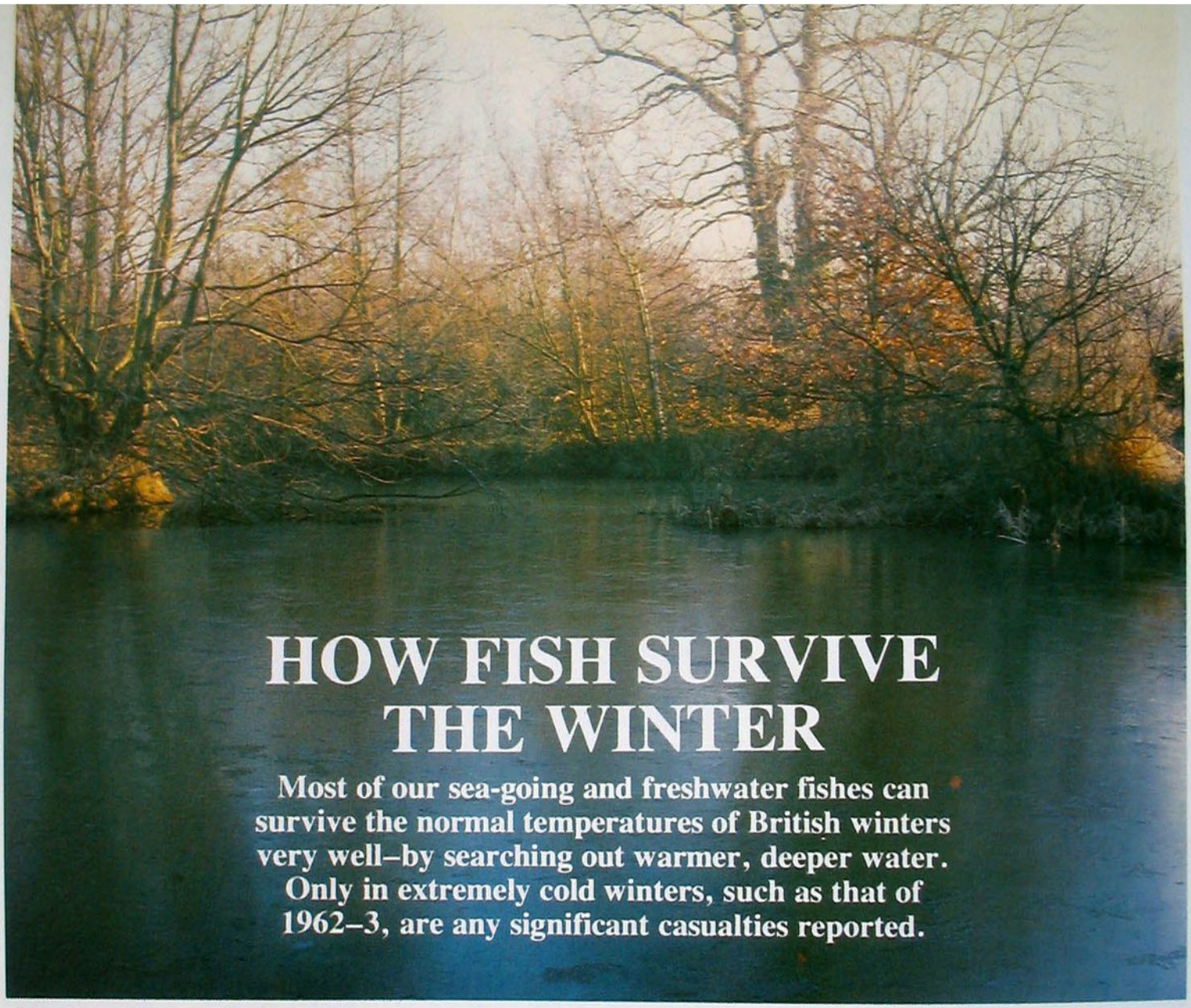
Sweet-smelling wood All cedars have a similar yellow-white durable timber that does not warp. These qualities make it ideal for high-class furniture and joinery. But its greatest characteristic is its sweet aromatic smell, which in Victorian times made the wood much sought after for linen cupboards and chests of drawers.

True and false cedars Many species of trees are commonly called cedars, even though they are not true cedars. This confusion began with the early settlers in the United States, who called several evergreen aromatic trees that they discovered 'cedar'.

A similar thing happened to aromatic conifers from other parts of the world and now there are species of juniper, cypress and thuja that are incorrectly called 'cedar'. But none of these can be compared to the magnificent sight of a mature *Cedrus* species.

Above and left: **Atlas or Atlantic cedar** *(Cedrus atlantica)*. Introduced evergreen, native to the south-west Mediterranean. The variety *glauca*, with its blue foliage (see above), is more common in Britain than the species which has green foliage (see left). The branches of an Atlas cedar often ascend.

Below: The bark of the Atlas cedar. All cedars have similar bark: dark grey and breaking into flat scaly plates.



HOW FISH SURVIVE THE WINTER

Most of our sea-going and freshwater fishes can survive the normal temperatures of British winters very well–by searching out warmer, deeper water. Only in extremely cold winters, such as that of 1962–3, are any significant casualties reported.

Fishes are cold-blooded animals, and most of them are unable to regulate their body temperature which is not maintained at a more or less constant level as man's is, for example; instead, their body temperature is influenced by their surroundings. This means that fishes living in Arctic seas in winter have a body temperature very close to the freezing point of fresh water, while others living on tropical coral reefs have a temperature around the level of a tepid bath. Not surprisingly, no species of fish occurs in both habitats.

Change of habit The ability to live with a body temperature the same as that of their surroundings has several important consequences for fishes. In temperate areas, like Britain, the temperature may vary greatly during the year. A minnow living in a small stream may be in water just above freezing point in winter, but at 20°C (68°F) in summer.

This change in temperature greatly affects the fish's body metabolism. In winter, the minnow is sluggish, probably lying close to a boulder in the stream bed or hiding in the vegetation at the edge of the bank, hardly moving, breathing slowly and not feeding. The same fish in this stream in summer is very active. All its internal systems function at their peak and, as a result of the abundant food, the fish grows–something that does not happen in winter. In lakes and ponds fishes behave similarly, and in a severe winter they tend to live quietly in deeper parts of the lake.

Water and ice Water is an unusual substance in the way it reacts at very low temperatures. It contracts as it cools, until it reaches a temperature of 4°C (39°F), when it begins to expand. It continues to expand until it reaches freezing point.

In a very severe winter the surface temperature drops, the water contracts, its density increases and it sinks from the surface to the bottom. However, once the surface temperature drops beolw 4°C (39°F), the water expands instead of contracting. It becomes less dense, and therefore stays at the surface. Eventually ice forms at the surface and,

Above: In severe winter conditions, ice will form even on large areas of water. To survive, fishes and other aquatic life seek out the deeper parts. Here they are relatively safe since the water under the ice eventually settles at a uniform temperature above that of freezing point. Occasionally you may see fishes frozen in deep ice on ponds; they almost certainly died because ice crystals formed in their bodies, breaking down the cells of vital organs.

Right: This map of British waters shows where certain sea species–namely the tunny, blue shark, cod and sole–move to in winter when the temperature of the water drops due to severe cold conditions.

although it gradually becomes thicker the longer the frost lasts, the water beneath stays unfrozen and between freezing point and 4 C (30 F) for weeks on end.

Fishes can thus survive in this unfrozen water through long periods of hard frost, although they do so by reducing their life activities to a very low level in response to the low temperatures.

Casualties Fish mortalities due to ice cover are rarely high, except in certain ponds which are either very shallow or have a dense plant growth on the bottom. In the latter case, if the icing over of the pond is followed by a snowfall, light is cut out and the plants produce more carbon dioxide than oxygen. In these cases, the water in the pond may become deficient in dissolved oxygen and, if there are a lot of fishes present, many may die. Fortunately, this happens rarely in Britain and then mainly in ornamental lakes in parks and gardens.

Deep retreat Most wild fishes, however, suceed in avoiding the worst of winter by migrating into deeper, and thus warmer, water. In rivers in very cold winters the fishes tend to accumulate in deep pools, where the water stays marginally warmer, or they move downstream, which often brings them into deeper water and even into the upper estuary. Similarly, in very severe weather the fishes in large natural lakes tend to quit the cold small tributary streams and shallows and move into deeper water.

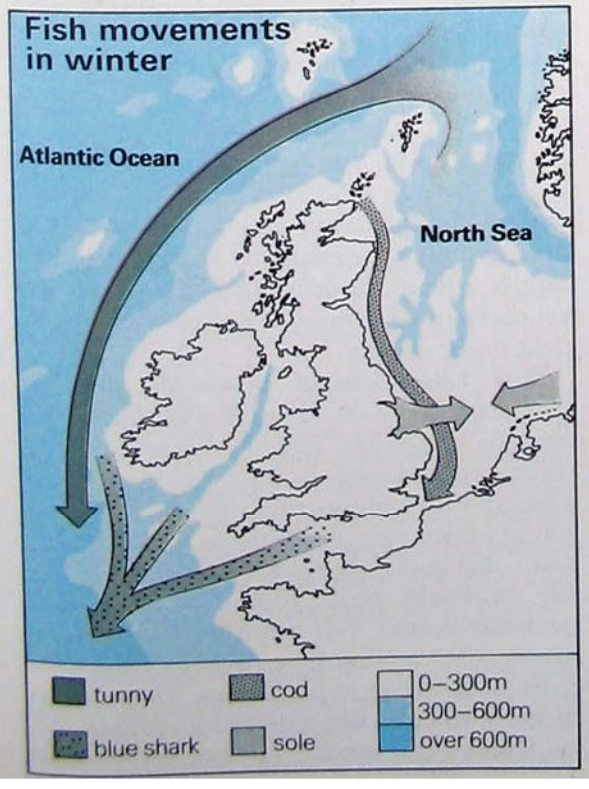
Easier at sea Sea fishes are much less vulnerable to the adverse effects of severe cold, mainly because of the vastness of the sea, which retains its warmth and rarely becomes as cold as rivers and lakes. The sea also has the advantage of a much lower freezing point than fresh water, due to the salt that it contains. However, in exceptionally severe winters, there is a mass migration of fishes from the shallow inshore waters and river mouths into deeper water to avoid the cold.

The most severe impact of prolonged cold is on those fishes, like the blennies and gobies, that live mainly between the tide-marks and in very shallow water. While many of them migrate into deeper water, some may not find suitable habitats, and so die. Severe cold can also affect the fishes' food supply by reducing the quantity of invertebrates and marine algae available.

Even in deeper water not all the fishes are safe. During the intense cold of the winter of 1962-3, North Sea trawlers caught large numbers of dead soles, among other fishes. These flatfishes are particularly sensitive to cold and they tend to congregate in the deeper parts of the southern North Sea.

Fishes generally live through winter by lying low and making fewer demands on their environment by being inactive and feeding less. It is this that allows them to survive in an environment that appears inhospitable to us.

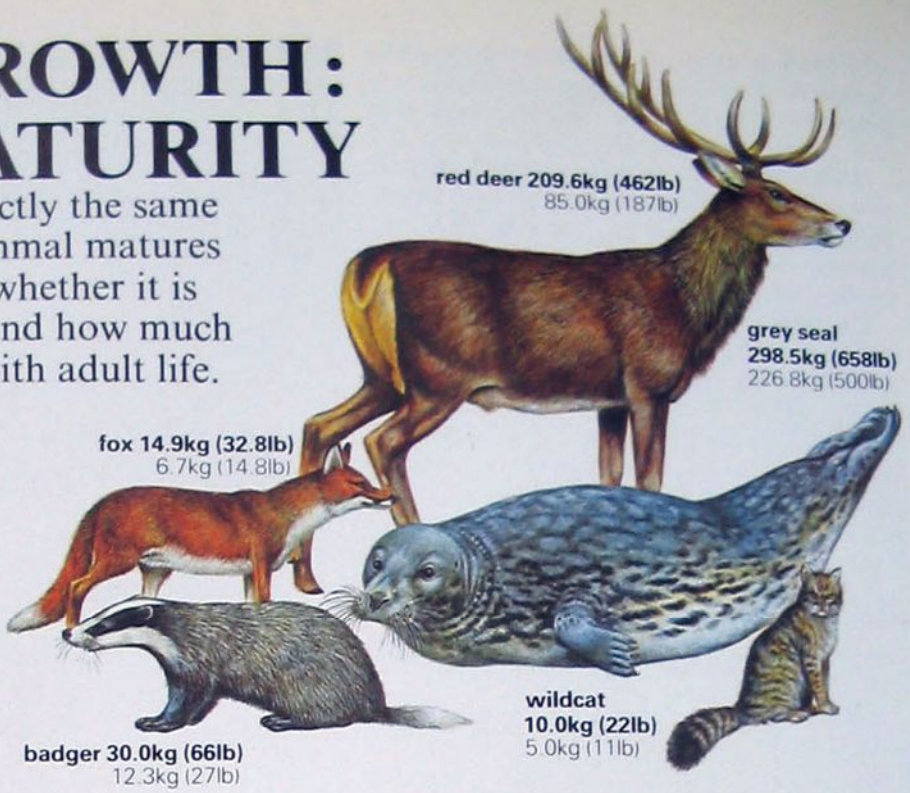
Above: Species like the salmon *(Salmo salar)*, spawn in winter, laying their eggs among gravel, often in shallow, running water. The eggs survive and develop in water temperatures down to freezing point but development is slow and mortalities increase at very low temperatures. A positive consequence of the long growth period is that the fry are born at a time to take advantage of the abundance of food animals that appear in the spring.



Below: Conger eels *(Conger conger)* are near the northern extremity of their range in British waters. This probably makes them more sensitive to the cold: they suffered many casualties in the 1962-3 winter.

MAMMAL GROWTH: BIRTH TO MATURITY

No two mammals develop at exactly the same pace. How quickly the youg mammal matures depends on where it was born, whether it is born helpless or well developed, and how much it must learn before it can cope with adult life.



Above: Extremely large weights have been recorded for some British mammals. This line-up of heavyweights probably represents freaks of nature, although they must have had a considerable number of favourable environmental factors to help boost their size. The smaller measurements given beneath in lighter type refer to the *average* weight recorded for each species.

The struggle for survival affects all life on earth, but the birth and development of mammals is of particular interest, because of their similarities with our own development.

At birth a young mammal is entirely dependent on its mother for food in the form of milk, this nourishment giving the growing baby the start it needs on the road to maturity. By the time the baby mammal is able to eat the same food as its parents, it can be said to be in its 'childhood', a period of growing up that ends when the mammal reaches sexual maturity. The animal may still increase in weight and continue to grow in size beyond the time it reaches breeding age, however, and in certain species, some parts of the body – teeth, nails, hoofs and horns, for instance – continue to grow throughout life.

Facing the world Some baby mammals are able to stand within a few minutes of birth,

Left: Dormouse babies, born naked, blind and helpless, remain in the nest and feed on milk for the first 21 days of their lives.

Below: A roe deer fawn, though ready to run soon after birth, lies quietly hidden in the undergrowth during its first few days of life. Its mother visits every few hours to suckle it.

and in hours they can cope with their strange new surroundings. Other mammal babies are blind, naked, deaf and helpless at birth. The reasons why there is such a difference depend on the habitat of a particular species, as well as the kind of life it leads as the young grow up and mature.

Born in the open A mammal which is hunted for food by other animals, and which is born in an exposed site, usually appears at birth fully furred and with its eyes open and ears pricked; it is also able to stand within a short time of birth and to run with its mother if danger threatens.

To enable this to happen, the mother that bears a fully developed baby carries it in her womb for a long period of growth – the gestation period. Since her offspring are quite large she usually gives birth to only a few babies at a time. Hoofed mammals – horses, deer, sheep and goats – all belong to this group. The young also have strong legs so they can run with their mother or with the herd. Although these young stay near their mothers and are nourished by her milk, they require little of the cossetting given to the less well-developed young of other species, and grow quite rapidly.

Birth below ground Mammals that give birth in a burrow or other secure site generally produce helpless, less developed babies. Shrews and hedgehogs, rats and mice, foxes, wild cats and badgers, and rabbits all produce young of this variety. Because the babies are small – being less developed – the mother usually produces large litters, after a short gestation period. For example, the common shrew, after a gestation period of 16 days, gives birth to five to ten babies. These babies develop very quickly; so quickly, in fact, that the females can produce a litter within a few

The growth of horns

The horns of bovid mammals (sheep, cattle, antelope and goats) are one of the parts of the body that grow continually throughout the animal's life. A horn consists of a hollow sheath overlying a bony core. The sheath is made of hardened skin, as are claws, hoofs and finger and toe nails. As the mammal ages, both sheath and core grow at the base. A new segment is grown each year; if you count the segments you can determine the animal's age. The segments are separated by very dark rings which represent the check in horn growth in winter. These can be clearly seen on this goat's fine horns.

months of their own birth. This speedy development is important, because the lifespan of most rodents and insectivores is short. There is also a large loss through capture by predators such as the larger meateating mammals (foxes and stoats) and birds of prey (kestrels, sparrowhawks and owls).

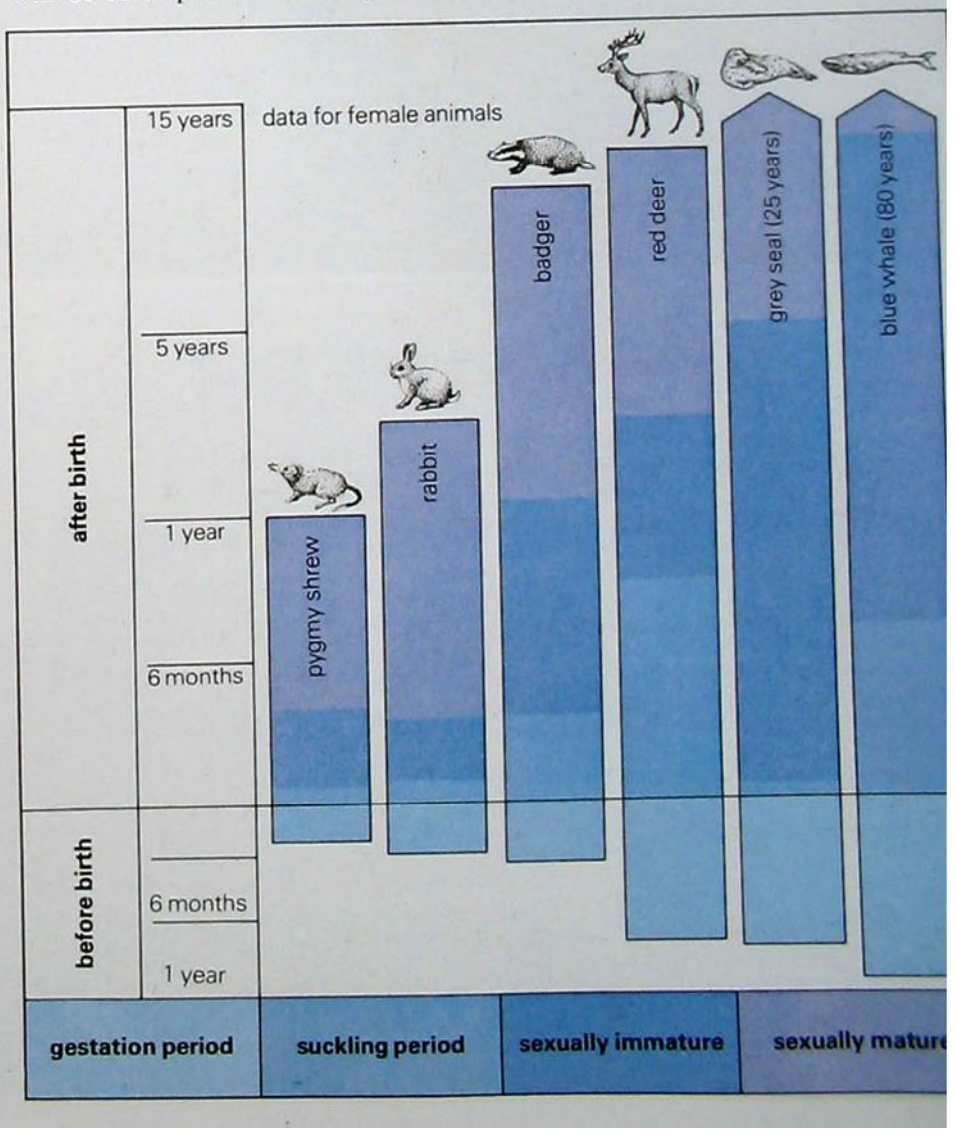
Childhood can be regarded as the time between when the young are weaned to when they reach sexual maturity and can bear their own young. The childhood of a fox cub is, for example, very different from that of a red deer calf. Although the deer calf stays with or near its mother, it requires far less attention than a litter of fox cubs. One reason for this is that the two species have completely different feeding habits. The deer, and its hoofed relatives, feed on plants and are social animals living in herds. They are continually on the move, searching for new plants to eat and always on the lookout for enemies. Babies must therefore be able to keep up with the herd. Young foxes, on the other hand, have to learn the skills of hunting and survival from their mother–a process that takes time.

Maturity in a mammal can be defined as the time when the young individual has reached the point of being able to reproduce. The female is usually the first to reach this point. When a mammal is sexually mature it will not develop further although, as has been stated, it may grow larger and heavier with age. Although certain parts of a mammal's body continue to grow throughout its life, the animal's life style is usually geared to cater for this phenomenon. Thus the teeth of a rodent continue to grow, but are worn down by the animal gnawing. The hoofs of ungulates (hoofed mammals) also continue to grow, but they are kept short by movement over rough ground. However, captive mammals do not always have sufficient exercise on hard ground and their hoofs often become long and upturned. The horns of bovids such as the goat also grow throughout the animal's life.

Growth rate and maturity The development and life expectancy of any animal can be very variable, and depends on many factors, including habitat, climate, predation, disease, competition, parasitic burden and the quality and abundance of available food.

In wild rabbits, for example, up to 90% of all babies born die in their first year. During this crucial period they are at their most vulnerable, and succumb quickly to the effects of harsh weather and food shortages; they are also easily caught by predators at this time. The survivors decrease in numbers over the ensuing years, and very few reach the old age of six or eight years. Those that do survive will age, their structures and functions deteriorating progressively. Probably none will die of old age alone, but their inability to resist disease and repair damaged parts will be so impaired that they will die.

Below: This chart compares the rates at which certain mammals mature, and their maximum life expectancy, as well as showing the duration of gestation (the period of development within the mother's body), suckling (the length of time until weaning), and childhood (the time taken to reach sexual maturity). In general, the larger the animal the longer its gestation period.



PIED PIPERS OF THE COAST

With its pied plumage, pink legs and red bill the oystercatcher is one of our most distinctive shore birds. It has several strange patterns of behaviour, including an unusual 'piping display' performed in the breeding season to defend its territory.

Oystercatcher *(Haematopus ostralegus)*. Resident wader, found on rocky shores (exposed headlands as well as sheltered bays), mud flats and sometimes inland, particularly in Scotland. Length about 40cm (17in).

Most of our coastal waders are dull brown and difficult to distinguish from each other, but the oystercatcher is an exception. Its orange-red bill, red eyes and pink legs stand out strongly from its stark black and white plumage. Yet if you come across an oystercatcher while it is quitely feeding it can seem an inconspicuous bird, particularly if its back is turned towards you. Only when it is disturbed and looks up does it reveal its remarkable colouring.

Sexes alike Male and female oystercatchers are similar in appearance. The upperparts are predominantly black, with white wing-bars, rump and base of the tail. During the breeding season in spring and summer the black part of their plumage becomes glossy. In winter it is duller and the birds develop a white collar round the front of their necks. Young oystercatchers retain the white collar and duller plumage all the year round.

The adult bill is orange-red, tending to become yellower towards the tip. In younger birds the tip is duller yellow-brown. The bill is about 7cm (3in) long, the female's being slightly longer than the male's. The legs of the adult are pink but in young birds are greyish. The colour of the eyes also develops as the birds mature. In their first year, oystercatchers have brown eyes. As they grow older, these become yellow, then orange and finally red by the time the birds reach adulthood. The red of the eye is accentuated, again

Above: A pair of oystercatchers during the breeding season. In winter their coats are much less glossy and the birds develop an irregular white collar round the front of their necks.
Oystercatchers usually mate for life and, during the breeding season, are strongly territorial.

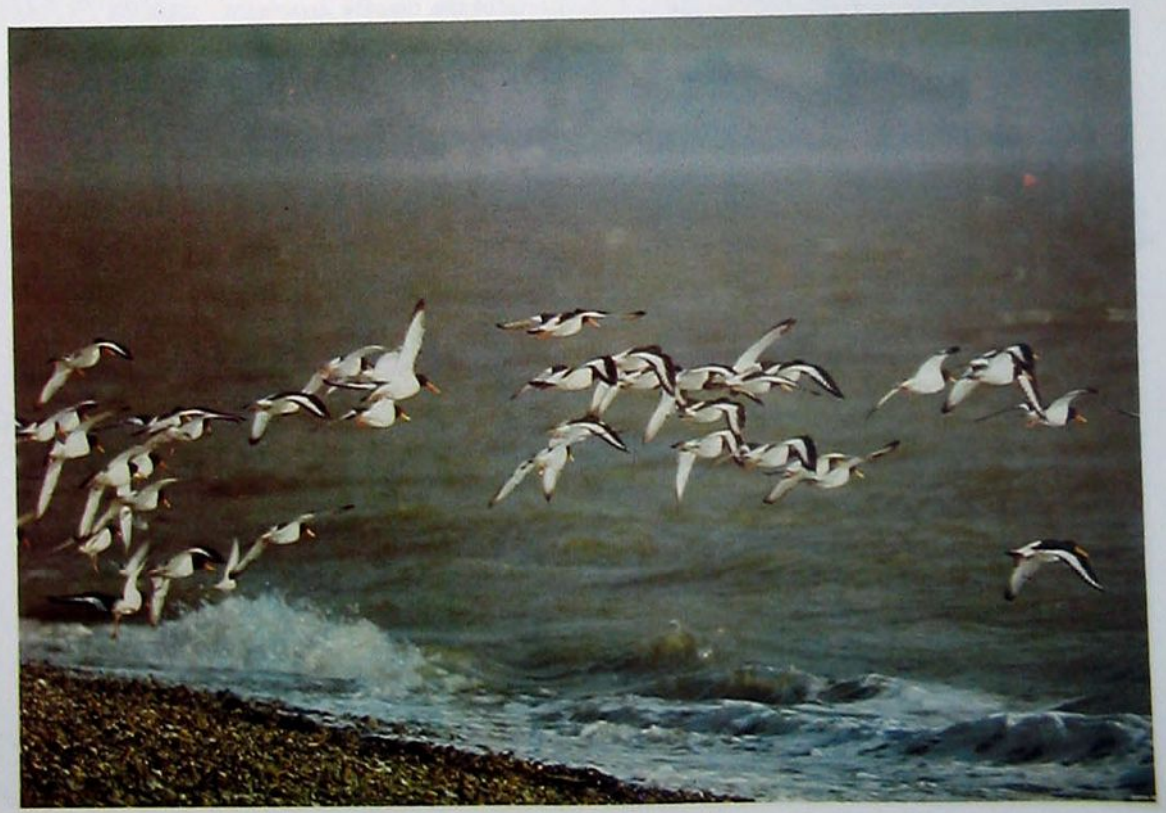
primarily in the adult, by a ring of red feathers surrounding it.

Coastal and inland habitats Oystercatchers occur in a variety of habitats, primarily coastal. On rocky shores they feed on both exposed headlands and sheltered bays, though the number of oystercatchers found there is never great. Larger numbers are found on mud flats, where the birds can probe for worms and shells. On extensive mud flats, such as those of the Wash, Morcambe Bay, Solway Firth and the Burry Inlet, huge winter flocks numbering 10,000 or more can be seen. As high tide approaches the birds fly off noisily in flocks to roost together in dense packs above the high-water mark.

During the last hundred years oystercatchers have been moving away from the coast to take advantage of inland feeding sites–after all, probing for worms in soil is much the same as probing for worms in mud. In northern Britain and particularly in Scotland they are now common farmland birds often seen feeding in association with lapwings, rooks, starlings and those other inland invaders of recent years: gulls. The reason for this movement is not known, but increasing human disturbance of the coast, and even a genetic change in the birds themselves, have been suggested.

Oyster catchers no more The name 'oystercatcher' is a misnomer, for the bird rarely eats oysters these days. Inland feeders live off earthworms and other soil invertebrates; coastal dwellers eat mostly crabs and shellfish such as limpets, cockles and mussels, though worms are commonly eaten.

The oystercatcher shows great skill in the way it extracts the meat from a shellfish. It takes the shell to a rocky or sandy surface that will give good support, placing the



Right: In winter oystercatchers form themselves into large flocks.
To identify an oystercatcher in flight, look for the white underparts with black head and wing tips. Of the more colourful parts of an oystercatcher, only its pink legs are distinct in flight.

Left: An oystercatcher's nest is usually a simple hollow, sometimes lined with stones, shells or dead vegetation. The number of eggs laid is normally three, but may be two or four. The eggs are large, about 6cm (2½in) long, and often pointed.

Below: If the chicks are threatened, one of the parents sometimes feigns injury or pretends to be brooding to draw the predator towards it and away from the young.

Below: During the breeding season an oystercatcher announces and defends its territory with a piping call and a strange posture: the neck is extended with the bill open and pointing down. Both partners may perform the display.

Bill shape and feeding

An oystercatcher attacks shells in one of two ways, depending on how it was taught by its parents. Which method it uses is reflected by its bill. If the bird stabs its bill between the shell valves the bill remains sharp, but if it hammers the side of the shell the bill becomes blunt.

weakest part of the shell uppermost. Then it either stabs through the gap between the shells or hammers the shell repeatedly until it can get its bill inside. Once inside the shell the oystercatcher uses its bill to sever the muscle attaching the flesh to the shell and eats the flesh.

This method of feeding illustrates some interesting adaptations. The bill is sensitive enough to detect food when probing in sand or mud, yet it is also tough enough to break through hard shell.

Close examination of shells attacked by oystercatchers show another strange feature, equivalent to our own right-handedness or left-handedness. The birds have a preferred side from which to attack the shell. For example, if you investigate damage to limpet shells made by oystercatchers you'll see that most blows are delivered with the head and bill turned to the right.

Strange displays Throughout the winter oystercatchers flock together but in March, with the start of the breeding season, they separate into pairs–oystercatchers mate for life–and establish a territory.

The courtship and territorial behaviour both include some unusual displays. During courtship the 'butterfly-flight' display is performed; in this the male flies over his territory with slow exaggerated wing-beats. Sometimes he pursues a female but equally often the male is alone.

More bizarre is the territorial display with its associated 'piping' call. This begins with a series of clearly spaced, loud notes. These gradually quicken until they become a prolonged trill. At the same time the bird adopts a peculiar posture with the neck partly extended, the shoulders raised in a 'hunchback' attitude and the bill open and pointing downwards. A bird performing this display to

Above: A flock of oystercatchers waiting for the tide to recede.

defend its territory may be joined by its mate and by birds from adjoining territories to form a party of piping birds. The piping call may also be given in flight, again to defend territory.

The more usual call of an oystercatcher is a fluty 'kileep'. When alarmed or excited this may be varied to a repeated 'kleepa, kleepa, kleepa'.

Nest, eggs and young The typical oystercatcher nest is a simple hollow or scrape, sometimes lined with stones, shells, or dead vegetation. Favourite sites include coastal shingle, rocks and dunes, and river banks and loch-sides. As inland feeding becomes commoner, so does inland breeding, with nests being established in open cultivated fields.

Egg-laying usually takes place in May. The normal clutch is three. The eggs are incubated for about 25 days, mostly by the female. A few hours after hatching the chicks begin to wander, closely guarded by their parents. If danger threatens the parents sometimes try to distract the intruder by feigning injury or by settling into a brooding posture some distance from the chicks. More often they fly around calling: the warning cry causes the chicks to 'freeze' in a secluded spot where their camouflage makes them hard to find.

Oystercatcher chicks are unusual among waders in being dependent upon their parents for food; not surprisingly, since their bills are too small to break open shells. This dependence lasts until the chicks fledge at about 35 days old.

Numbers increasing Without doubt, the oystercatcher is our most successful wader, though why this should be so is not clear. The numbers of our own breeding birds–now well over 30,000 pairs–and of wintering migrants from Iceland, the Faroes and Scandinavia have increased dramatically in recent years, and a significant part of this increase stems from the oystercatcher's movement inland. This process is continuing, in both Britain and Europe. There seems little doubt that the population of our pied pipers will continue to increase for some years to come.

Oystercatchers and the cockle industry

The oystercatcher's fondness for cockles has brought it into conflict with cockle fishermen, who harvest this shellfish and depend on it for their livelihoods. The problem is particularly acute in South Wales, where our largest cockle beds are to be found, and is made worse by the fact that oystercatchers prefer two-year old cockles, which is also the main age-group taken by the fishermen. The abundance of cockles fluctuates considerably from year to year, making the life of a cockle fisherman precarious enough without oystercatchers adding to his problems, and limited shooting of these birds is now allowed in certain areas.

However, the impact of oystercatchers on the cockle population is still disputed, some people arguing that oystercatchers consume large quantities of cockles only in years when they are plentiful. Either way, short of extreme measures there is little that can be done to control the activities of such a successful species.

WINTER VEGETABLE HARVEST

Vegetables such as carrots, turnips, swedes and parsnips are so familiar that it is very easy to forget that they are actually roots—the hidden but vital parts of plants.

Above: The feathery carrot tops in the field are an indication of the carrot's relationship to parsley.

The root system plays an essential part in the growth and development of a plant; it anchors the plant firmly in the soil and is the pathway through which water, salts and other compounds are taken up. It also synthesises hormones, complex organic molecules, which are transported to the shoots and are vital for normal development. If its roots are restricted in their growth by poor stony soil, or by waterlogging, or by buildings, then the development of the plant is retarded and its growth stunted.

Roots as food The root can, and often does, provide a store of food for the plant and many plants have been developed over the years to produce roots that will provide food for man and his animals. These plants come from a wide range of different families and include vegetables such as beetroots, carrots, horseradishes, parsnips, salsify, swedes and turnips, with carrots, parsnips, swedes and turnips being the most widely grown.

All these vegetables are biennial; they develop swollen roots containing products stored from various metabolic processes, during the first year of growth. In the second year, they utilise the stored material to produce numerous flowers and, finally, seeds. Man intervenes before the second year, lifting his crop during the autumn and winter periods.

Parsnips are grown in three main shapes—bayonet, like this variety (below), bulbous and wedge.

The Parsley family As well as the hemlock and the giant hogweed, the parsley family includes the carrot and the parsnip. Carrots have been cultivated for over 2000 years and are probably derived from western Asiatic forms of the species. Their ancestor, the wild carrot, grows all over the British Isles, and its large, yet delicate, flower heads have given it a variety of popular names, such as Queen Anne's lace. Though not common here, white and yellow-rooted varieties of carrot are grown in some European countries, primarily for stock feed, while in India purple-rooted varieties are grown for human consumption.

Carrots grow best on deep, well-drained, stone-free sands and peats, where the roots can develop without restriction. They are sown in the field from February to May, for harvesting from July right through the following winter and spring. Alternatively, they can be sown in unheated greenhouses or plastic tunnels during the winter months, for a crop in the following February to June period.

The seed is drilled in rows and thinned to allow development of the elongated, swollen tap root. The dry matter in the roots consists

primarily of sugars; but carotene, which is largely responsible for the colour, is also a valuable component since it is produced as part of the process of manufacturing vitamin A by the plant. The familiar red or orange varieties are grown either for direct human consumption, or for canning, with a yield of about 525,000 tons per year, and an estimated value of £35 million.

Slow-growing parsnips Often the earliest vegetable to be sown outside the greenhouse, parsnips are not harvested until the following winter, which allows the roots to develop in the ground for almost a year. They should be dug up by February if required as a vegetable, since they begin to develop new leaves and use up their stored food reserves after that.

Because they stay in the soil for such a long time, other quicker-growing vegetables such as lettuce or radish are often grown between the parsnip plants, thus making rather more use of the space they take up. However, this may limit the growth of the parsnip, and this in conjunction with its low seed germination rate means that it has a rather limited capacity as a winter vegetable.

Relatives of the cabbage The turnip is a member of the cabbage family, and is related to the cauliflower, Brussels sprout and sprouting broccoli. Unlike these latter vegetables whose flowers and leaves are the main source of food, the swollen bulbous base of the stem and the upper section of the root provide the edible part.

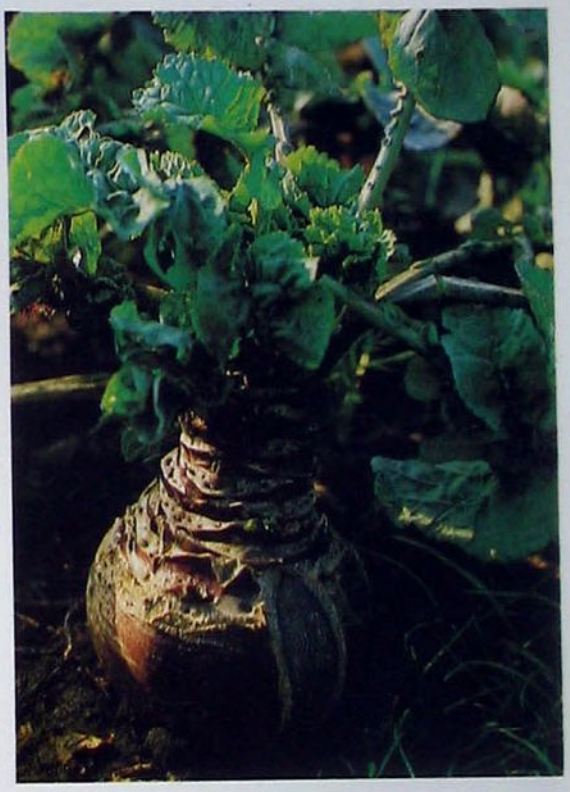
Commercially, turnips are a market garden crop, the estimated area of land upon which they are grown in England being less than 400 hectares (1000 acres). The principal growing areas are in Worcestershire, Bedfordshire, Surrey, Sussex and Kent.

Turnips have recently gained a new lease of life for two reasons. Firstly, their use in stew-packs with carrots, onions and other vegetables has made them very popular in the frozen vegetable market. Secondly, farmers often sow turnip seed after a cereal crop so that cows and sheep can graze on the tops in the autumn.

Foreign relative The swede is also a member of the cabbage family. It is thought by some to be of hybrid origin between certain races of cabbages and turnips where the two species overlapped in their original habitat (from western Europe to eastern Asia). Man's selection of desirable types over many hundreds of years is responsible for the form of the swede today.

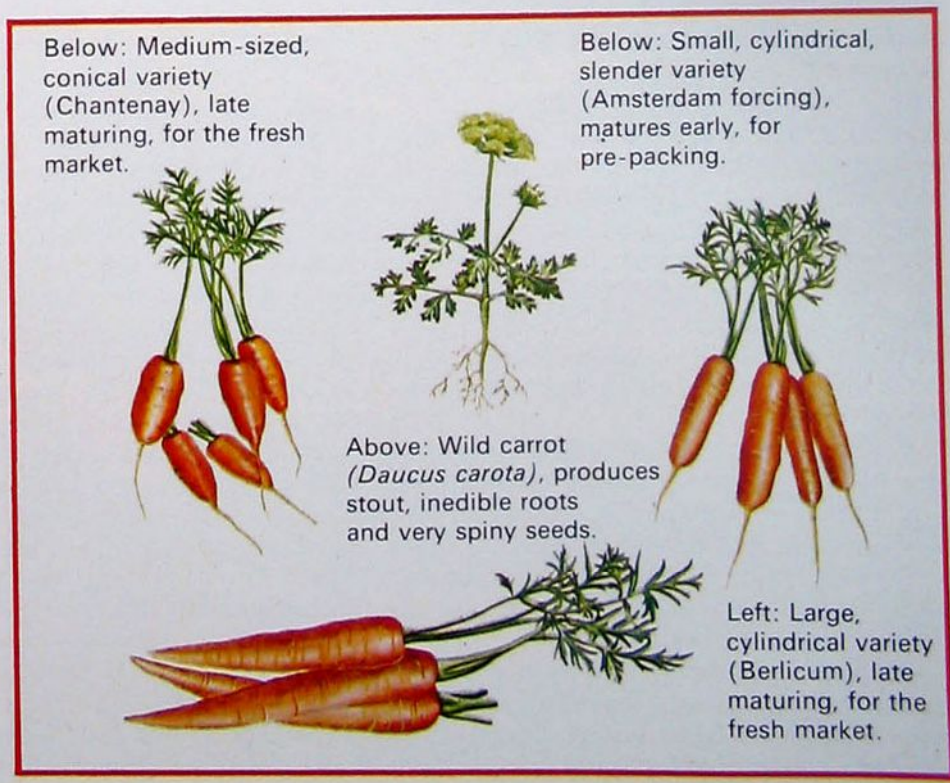
Swedes are widely grown in this country– a conservative estimate would be 2400 hectares (6000 acres) in production, mainly in the wetter areas of Devon, Somerset, Yorkshire, Lincolnshire and Lancashire. Most of the harvesting is done manually, commencing in September and ending in the following May. During periods of hard frost (when prices are high) a reserve supply of roots can be stored in open sheds.

Above: Varieties of the turnip *(Brassica campestris* var. *rapifera)*. These are generally globe-shaped, with white flesh and smooth, blue-green leaves. Young turnip tops are also eaten as a vegetable. In some parts of the country the turnip is rather confusingly known as a swede.



Right: By 1800 the swede *(Brassica napus)* had spread to the British Isles via Scotland from Sweden (hence its name). Swedes are normally an elongated globe-shape, with ridges and leaf scars on the neck. They have purple skins with yellow or white flesh and green bushy leaves.

Below: Carrots are grown in several different root shapes and sizes, for a variety of markets.



Below: Medium-sized, conical variety (Chantenay), late maturing, for the fresh market.

Below: Small, cylindrical, slender variety (Amsterdam forcing), matures early, for pre-packing.

Above: Wild carrot *(Daucus carota)*, produces stout, inedible roots and very spiny seeds.

Left: Large, cylindrical variety (Berlicum), late maturing, for the fresh market.

SCUTTLING SCAVENGERS

The cockroaches you find living in buildings as household pests are invaders from warmer lands, but there are three small British species living secluded lives in the wild.

Cockroaches, belonging to the order Dictyoptera, can usually be recognised by their flattened bodies and the big 'shield' (pronotum) beneath which the head is tucked. The antennae are long and slender and perpetually quivering, and the insects run very swiftly on their long spiky legs. The wings of many species are no more than little flaps just behind the pronotum, but some species are fully equipped with leathery front wings and broad, membraneous hind wings. Some of the winged species can fly, but they rarely do so and their wings remain folded neatly on top of the body.

Essentially warmth-loving insects, most of the 4000 or so known species of cockroach live in tropical regions. They are often very numerous on the forest floor, where they feed on a wide range of plant and animal matter, including fallen fruit and leaves and assorted dead insects and other animals.

With these scavenging habits, it is not surprising that cockroaches have moved in with man and become household pests, for our homes and other buildings provide them with abundant food of all kinds. Our buildings also provide them with warmth, and several tropical species have been able to spread all over the world by adopting an indoor life. These are the so-called domestic cockroaches, although they do not live just in houses. In fact, with modern hygiene and insecticides, they are not at all common in houses now, but they still cause problems in warehouses and other heated buildings. They can be especially troublesome in the kitchens of large institutions such as schools and restaurants which are unoccupied at night, for cockroaches are active at night and less likely to be noticed in such places by day until their populations are quite large. By day, the insects retire to heating ducts and other warm refuges where they are difficult to find. Their flat bodies enable them to squeeze through minute cracks in walls and floors.

Egg purses Mating in cockroaches takes place after a simple form of courtship, the female attracting the male by emitting a strong scent. The female produces her eggs soon after mating, enclosing them in a horny,

Above: A common cockroach *(Blatta orientalis)* sitting on mouldy bread cleaning its antenna. With their biting jaws, cockroaches can tackle all kinds of solid food and they will chew their way through endless layers of packing material to get at the goods. Stored food must therefore be very well protected where there is any risk of cockroach infestation. Even a small population can do immense damage to food—not by eating it all but by contaminating it with oily secretions and a very unpleasant smell. The best way to avoid infestation is to ensure that there is nothing for the cockroaches to eat—no scraps of food left lying about at night.

purse-shaped case called an ootheca. Most species drop the ootheca soon after it is formed, but the German cockroach carries it around until the eggs are about to hatch. The oothecae are very easily transported in produce of various kinds, and this is how many new cockroach infestations are started.

The commonest domestic species is the poorly-named German cockroach which is probably a native of North Africa. It is a pale brown insect with two dark stripes on the head-shield. Although both sexes are fully winged, they are reluctant to fly. This cockroach probably arrived in Britain on board ship during the 17th century. Although confined to the ports at first, it spread fairly rapidly through the country. Nowadays it is the most frequent cockroach in dwelling houses, and it is also common in bakeries, restaurants and hot-houses. In hot summers it often moves outside and establishes itself in rubbish dumps.

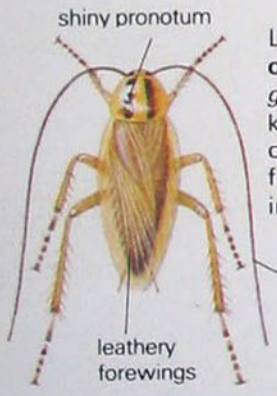
During courtship, a pair of German cockroaches stroke each other with their antennae and the male raises his wings so that the female can get at the secretions on his back. He then slides backwards underneath her to mate. The ootheca is 7-8mm long and 3mm wide and the female carries it around, protruding from her hind end, for about five weeks (or rather less in hot conditions). It contains 35 to 40 eggs, and the female usually produces about six oothecae during her life.

The eggs hatch soon after the female drops them and the young cockroaches mature in about three months at normal room temperature.

The common cockroach, also known as the oriental cockroach and the black beetle, averages 22mm ($\frac{4}{5}$in) in length. The male is deep reddish-brown, while the female is blackish-brown. She has a rather pear-shaped outline, much broader in the abdomen than the male, and her wings are reduced to tiny flaps. The male's wings reach nearly to the end of his abdomen, but he still cannot fly. Probably a native of North Africa or southern Asia, this species arrived in Britain in the 16th century. It was widely distributed

Above: The American cockroach *(Periplaneta americana)*, 3-4cm (1-1$\frac{1}{2}$in) long, is the commonest shipboard cockroach and, indeed, is sometimes called the ship cockroach. Cannibalism is quite frequent in this species, and in its tropical home it regularly eats small insects.

Below: A female dusky cockroach *(Ectobius lapponicus)* among leaves and grass in Dorset. This species is native to southern England.

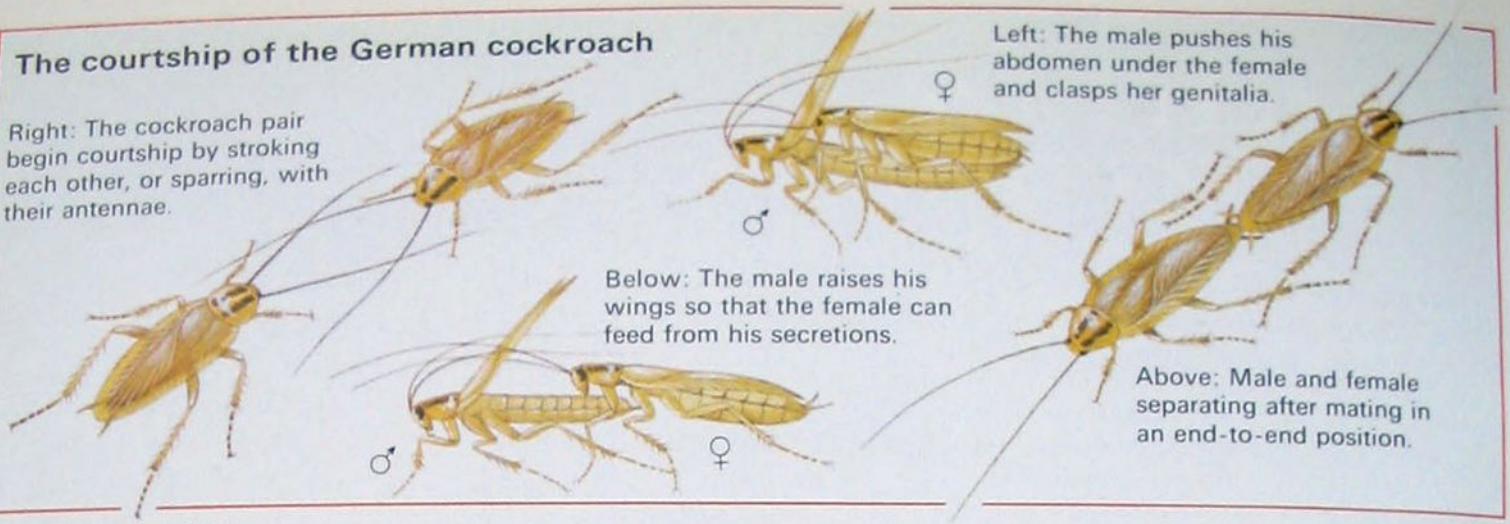


Left: **German cockroach** *(Blatella germanica)*, also known as the shiner or steam fly. Ranges from 10-15mm ($\frac{1}{3}$-$\frac{1}{2}$in) in length.

Right: **Lesser cockroach** *(Ectobius panzeri)*. Native to southern Britain, under 11mm ($\frac{1}{3}$in) long, and rarely found far from the coast.

Left: **Tawny cockroach** *(Ectobius pallidus)*. Native to southern Britain, much the same size as the lesser cockroach.

The courtship of the German cockroach


Right: The cockroach pair begin courtship by stroking each other, or sparring, with their antennae.
Below: The male raises his wings so that the female can feed from his secretions.
♀
♂
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♀
Left: The male pushes his abdomen under the female and clasps her genitalia.
Above: Male and female separating after mating in an end-to-end position.

Below: Nymphs of the American cockroach. The young insect is worm-like when it first wriggles out of the egg purse, but it rapidly breaks out of its first skin to reveal the typical cockroach shape. The nymph usually undergoes between six and twelve moults and becomes adult without any pupal stage. The wings can be seen as small buds on the backs of the older nymphs. Maturity may be reached in only six weeks in warm conditions, but the life cycle normally takes longer.

by the end of the 18th century and can now be found in houses and other buildings all over the country. It is not uncommon in sewers and on large rubbish dumps, where it may even survive the winter.

The courtship of the common cockroach resembles that of the German cockroach, with the male raising his wings and the female nibbling his back, although he does not actually seem to produce any secretions for her. The ootheca, about 10mm ($\frac{1}{3}$in) long and 5mm ($\frac{1}{5}$in) wide, is carried for a day or two then dropped. It contains about 14 eggs, which hatch in two to three months under normal conditions, but which may remain dormant throughout the winter if not in heated surroundings.

The American cockroach is chestnut brown and fully winged in both sexes, although it rarely flies in Britain. Despite its name, it is a native of Africa and arrived in America via the slave trade. It rarely occurs in houses in Britain, but is common in bakeries, restaurants and sewers.

A courting male American cockroach waves his antennae excitedly and raises all four wings when he picks up a female's scent, but he shows little finesse and quickly thrusts his abdomen beneath her. There is no food for her and she makes no attempt to nibble his back. The oothecae contain up to 24 eggs and are often cemented to the substrate or buried in debris. The eggs hatch in six to twelve weeks under normal conditions and the nymphs take over a year to mature unless they are living in very hot places. In cool buildings they may take as much as three years.

Cockroaches in the wild Our three native cockroaches are all under 11mm ($\frac{1}{3}$in) long and are rarely seen. Although they can be shaken from trees and hedgerows, they are mainly ground-living and can be found in leaf litter and among the turf of rough grasslands. They also inhabit heathlands and sand dunes. All feed mainly on dead plant material. The three species are the dusky cockroach, the tawny and the lesser. All are confined to southern England, and the lesser cockroach is rarely found far from the coast.

The lesser cockroach and the male dusky cockroach are greyish-brown, but the others are yellowish-brown. All the males can fly, and so can the female tawny cockroach, but the females of the other two species have reduced wings.

Courtship in all three species is similar to that in the German cockroach, with the female taking glandular secretions from the male's back. The oothecae are deposited during the summer, but the eggs do not hatch until the following spring. Nymphs of the lesser cockroach mature within three or four months, but those of the other two species go into hibernation and do not mature until their second summer. All adults die in autumn.

MORECAMBE BAY

Morecambe Bay, on the north-west coast of England, is Britain's largest estuarine habitat. An area almost the size of the Isle of Wight, it is alternately covered and exposed by the tide, and no less than four rivers flow into the Bay.

For an overall impression of the shape and extent of Morecambe Bay, visitors should view it from one of the hills at its northern end. On a clear day the view takes in the woodland around Silverdale, the low eastern shore with the long line of Morecambe Promenade, the industrial buildings of Heysham and Fleetwood beyond and the open waters of the Irish Sea. Away to the right are the cranes of the Barrow shipyards, the southern tip of Walney Island and Piel Island castle, the Furness coast and the Cartmel peninsula with the limestone cliffs of Humphrey Head, a botanist's paradise.

The appearance of the bay depends on tide and weather. A westerly wind at high water on a spring tide turns the whole area into an arm of the Irish Sea with waves lashing against limestone cliffs, pebble beaches and embankments. A few hours later, as the tide retreats, coastal saltmarshes appear and the main rivers meander through a vast expanse gleaming wet sandbanks. At extreme low water about 120 square miles of estuarine silts are exposed, making this the largest continuous intertidal area in Britain.

This twice-daily transformation accounts for the wealth of invertebrate life in the Bay and the huge number of wading birds, wildfowl and gulls that feed upon it.

Marine life The Bay is a source of food for man as well as wildlife. Cockles used to be taken in great quantities, especially by the

Above: Morecambe Bay from Kent's Bank, at low tide

Below: A shore crab awaits the return of the tide. Here it shows its red underside, but its back is greenish-brown. The crab is about 4cm (1¾in) long.

Above: Sandwich terns on the beach; in flight the sea terns are dramatically different from gulls—they fly faster, beating their wings more deeply than the gulls, whose flight tends to be more relaxed. Altogether four species of tern have formed colonies on Foulney Island, which has shingle beaches, a favourite haunt of the terns.

fishermen of Flookburgh. Although almost all the cockles were killed by frost in the severe winter of 1962–3, they are today making a slow recovery. Meanwhile the fishermen have turned to shrimping from boats, while whitebait, sprats and small flatfish are also taken; and flounders, known locally as 'flukes', are abundant well up the estuaries. Salmon fisheries were of major economic importance in the Bay centuries ago, but the numbers of salmon are now much reduced. Some are still caught, however, at the mouth of the Lune.

Fish, including eels, also provide food for the seals that are occasionally seen in the Bay. Further out in the Bay dolphins are sometimes seen. They, too, come to feed on the abundant fish resources.

Besides the larger shellfish, the sands are inhabited by a small pink bivalve, the Baltic tellin (*Macoma balthica*). This attains a size of 2.5cm (1in)—but is often smaller—and is remarkable for the immense numbers in which it occurs. Sometimes there are more than 2000 tellin in a square metre of sand. The tellin is a deposit-feeding organism, living buried in the sand but feeding through an intake tube on the tiny fragments of plant and animal matter that fall to the sand from the sea. When the tide is out, star-shaped suction marks in the sand betray its presence below the surface.

Among the many other creatures that lurk in the sand are lugworms and ragworms. It is this teeming invertebrate life that attracts such large numbers of waders such as oystercatchers, curlews and godwit.

Myriads of birds Oystercatchers are perhaps the most noticeable birds in the Bay at any season. They are experts at opening shellfish and frequent the large mussel-beds on and near the scaurs (or skears)—the outcrops of rock in the lower part of the Bay. Herring gulls drop the mussels from a height to break them open, while in winter the diving ducks—scoter, scaup, goldeneye and eider—plunge for them and crush the shells open with the sheer strength of their beaks.

However, it is the smaller waders that give Morecambe Bay its international importance

Tread carefully

The sands of Morecambe Bay are normally hard and firm even when wet. Until the opening of the Furness Railway in 1857, the main route for travellers to the north on foot, horse or coach was across eight miles of sands between Morecambe and Grange-over-Sands. But in places, especially up the estuaries, you may encounter quicksands – stretches of smooth wet sand that quiver at a touch and grip like a vice if their surface is broken. The other peril is the swift tide: walkers on the sandbanks can easily be cut off as it encircles them. On the Kent Estuary a high tide forms an impressive bore.

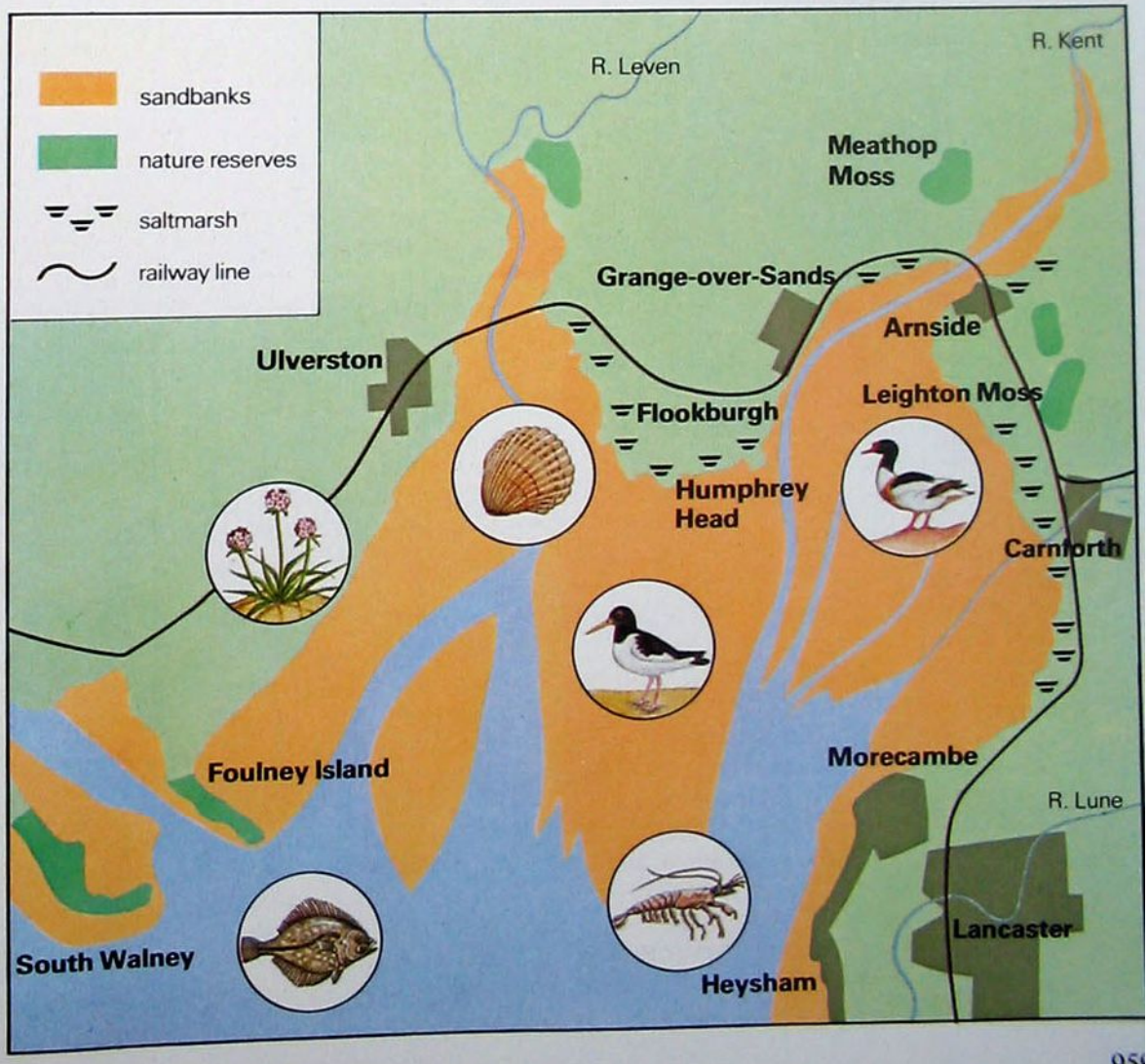
for ornithologists. Knot, dunlin, ringed plover, redshank, turnstone and sanderling – most of which breed in Greenland, Iceland, Scandinavia or Russia – are all seen here. Many of these birds winter on the Bay and many others stop to break their journey while migrating, in spring and summer. In preparing for their long migratory flights in spring, and in recovering from them in the autumn, the birds need the Bay's abundant food supplies to build up their strength and reserves of fat.

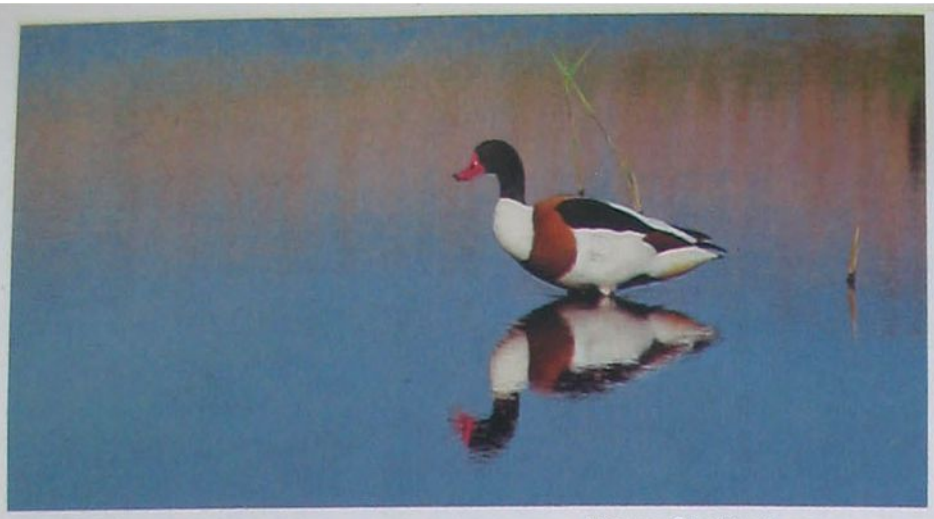
Saltmarshes are found chiefly on the eastern side of the Bay. They are highly changeable features – one near Silverdale has been halved by tidal erosion in just two years, while elsewhere high sandbanks are turning green with colonizing vegetation. In summer the marshes are pink with thrift and dotted with the white flowers of scurvy-grass. Only fine grasses can survive the frequent tidal invasions, while the cutting and sale of sea-washed turf has become a minor industry.

The largest marsh, near Carnforth, is so high that only the highest tides flood it, so oystercatchers, redshanks, ringed plovers and skylarks are all able to nest without too high a risk of suddenly finding themselves awash. For most of the year shelduck are conspicuous on both marshes and sands; they nest in holes or rock crevices inland.

In winter, gaggles of up to 200 greylag geese sometimes graze here. Recently, how-

Above: Townsend's cord-grass *(Spartina* x *townsendii)* is spreading in a few sheltered muddy bays. Here it is seen near Arnside, up the Kent estuary from Silverdale.





Above: Shelduck are conspicuous on both the marshes and sands in the Bay. Families of ducklings amalgamate to form creches, under the care of one or two parents, while the other adults perform their annual 'moult migration' to the North Sea in July. There they undergo a complete moult and renewal of plumage.

Left: In summer South Walney and its offshore islands are decorated with a variety of flowers, including the colourful viper's bugloss.

Below: This path through Leighton Moss has been made up with old railway sleepers. The Moss, perhaps the most important of the reserves in the region of the Bay, is run by the RSPB.

ever, their visits have been irregular, and the common wintering goose of the Bay is now the pink-footed, found in hundreds in fields south of the Lune estuary.

Ring of reserves The value of Morecambe Bay to naturalists is emphasized by the number and importance of nature reserves on or close to its shores. The best known is probably the great RSPB reserve at Leighton Moss near Silverdale, with its neighbouring woodland and saltmarshes.

The Moss itself, once an inlet of the sea, then arable farmland, is now a wide expanse of shallow meres, reedbeds and willow carr. The resident life of the reserve includes bitterns and bearded tits, while a great number of wildfowl spend part of the winter here. The reserve is also managed to give encouragement to the otter, one of our rarest mammals. Red deer, too, frequent the reserve, but this community is only an outpost–England's most important population of red deer is found on the other side of the Lake District, in Martindale Forest.

At the north-west corner of the Bay are two valuable reserves managed by the Cumbria Trust for Nature Conservation. South Walney, consisting of sand dunes, shingle beaches, saltmarsh and lagoons left by former gravel workings, contains a huge breeding colony of herring and lesser black-backed gulls and several hundred pairs of eiders.

In summer, the dunes and wasteland in the South Walney reserve are bright with flowers. In gravelly places the in-curled, blue-green leaves of the yellow horned poppy are seen; in August and September, its yellow flowers appear side by side with the long seed pods. It is primarily a colonizer of shingle, while another interesting species of the reserve, viper's bugloss, is a plant of dunes and cliffs. The deadly poisonous henbane,with hairy leaves and strong aroma, is a seaside plant that you can find in sandy places.

Foulney Island, normally accessible on foot by a stone causeway, has nesting colonies of four species of terns and provides nest sites for other species, and roosts for great wader flocks in winter. The island's shingle beaches and sand dunes are full of similar attractions for the botanist to those of South Walney.

Meathop Moss, another Cumbria Trust reserve, lies a mile inland from the Kent estuary. It is a valuable surviving example of the raised bogs on estuarine silt that were once numerous around the Bay. Nearly all of these have been destroyed by peat-cutting, drainage or afforestation, but at Meathop the Trust has worked hard to prevent the peat from drying out, and to halt the advance of birch and pine. The sphagnum bog has plentiful bog asphodel, bog rosemary, cranberry and cottongrass, and is famous for its wealth of insect life–60 species of larger moths are found in this quiet, colourful reserve.